American First Aeronautical Magazine
ESTABLISHED 1916

AVIATION

ANUARY 1946
0 CENTS PER COPY

IN THIS ISSUE

SPECIAL JET-ROCKET FEATURE SECTION

Design Analyses of General Electric's I-16 and I-40; also Westinghouse's 19-B turbojet — plus details of Gloster Meteor, Walter rocket engine, and basic story on JATO.

★

SMALL PLANE RADIO MAINTENANCE

You can "up" your profits and goodwill with a we'll-fix-it service for lightcraft radio. Here's how.

★

WANTED: AVIATION RETAILERS

Arthur Brown points the way to the long profits and gives the tipoff on getting your share.

★

NOBODY LOVES A HOT PILOT

Ideas that can save military pilots' lives — and operators' equipment.

★

WHAT PRICE FREE ENTERPRISE?

AVIATION'S Australian correspondent gages the battle of airline operators vs. government "nationalizers."

235745

NEW VOUGHTS ON THE WAY

The same engineering genius that produced the CORSAIR, fastest shipboard fighter of World War II, is now developing three new experimental types which will again raise the standards for combat aircraft. These include two radically new fighters as well as another marked advance in the CORSAIR series.

This progressive research and development program, typical of Chance Vought Aircraft for more than twenty-five years, will help maintain American security through supremacy in the air.

CHANCE VOUGHT AIRCRAFT
STRATFORD, CONNECTICUT
ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

ENGINEERING
LIBRARY

Serv-Air's modern hangar facilities at Raleigh Municipal Airport. During the war, Serv-Air did an outstanding job in Civilian Pilot Training and primary and advanced War Training Service. The airport is now wholly reconverted to peacetime operation.

Truman W. Miller, popular president of Serv-Air, Inc., has spent half his lifetime in flying, doing everything from barnstorming to advanced instructing. He holds a commercial license and, as CAA Airport Engineer, planned some 57 airports now active in the South. His development of Raleigh Municipal Airport is one of the success stories of aviation.

WHY FLIERS *LIKE* TO LAND AT RALEIGH

THE Raleigh, N. C., Municipal Airport offers everything a pilot needs. Here you can get anything from a new part to a new plane — efficient and complete A & E mechanics' service for minor repairs or major overhauls, fireproof hangar facilities, top quality aviation products, and friendly, personal attention — all in a convenient location ten minutes from town.

The man responsible for Raleigh Airport's success is Truman W. Miller, veteran flier and president of Serv-Air, Incorporated — one of the oldest airport operations in the South.

To go with its outstanding service, Serv-Air naturally provides outstanding aviation lubricants and fuels — *Texaco Aviation Gasoline* and *Texaco Aircraft Engine Oil exclusively.* These Texaco products are prime favorites at progressive airports throughout the country, and with leading airlines. In fact —

More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

This preference for Texaco by America's great airlines and airports is your best guide to satisfaction in the purchase of aviation lubricants and fuels.

Ask to see a Texaco aviation representative. He will gladly help you, wherever located, to select the right lubricants and fuel, and can often suggest improvements in maintenance practices. Texaco Aviation Products are available through more than 2300 Texaco distributing plants in the 48 States. Call the nearest one.

The Texas Company, *Aviation Division,* 135 East 42nd Street, New York 17, N. Y.

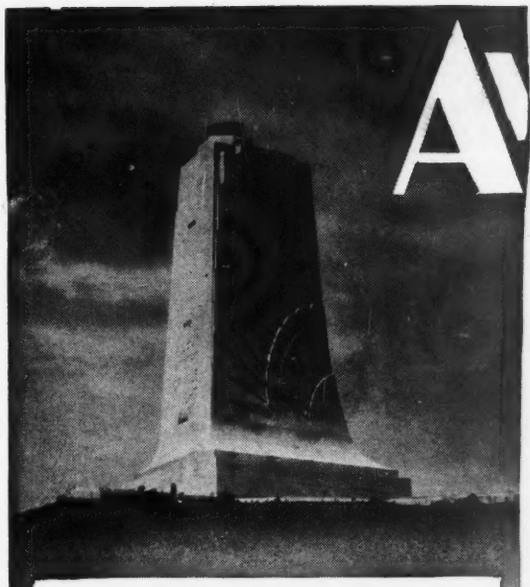
TEXACO

YOU

TEXACO Lubricants and Fu

FOR THE AVIATION INDUSTRY

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTI



AVIATION

CONTENTS FOR JANUARY, 1946

Volume 45 • No. 1

Briefing for January 5

Down the Years in Aviation's Log 5

Editorial: Take Eldon, For Instance— 39

Private Enterprise Fights to Keep Flying ..... *H. Bowden Fletcher* 40

Aviation Research—Engineering—Production

SPECIAL JET AND ROCKET ENGINE SECTION

Design Analysis of the General Electric I-16 Jet Engine *Maj. Rudolph C. Schulte* 43

Design Analysis of the General Electric I-40 Jet Engine *Dale D. Streid* 51

Design Analysis of the Westinghouse 19-B Yankee Turbojet *John Foster, Jr.* 60

The Engineering Behind That 606-MPH Meteor *A. H. Narracott* 69

The Rocket's Future Influence on Transport Designs *Dr. Martin Summerfield* 73

How Nazis' Walter Engine Pioneered Manned Rocket-Craft *Roy Healy* 77

Laminated Window Designs Forecast by Plastic Domes *Leonard M. Purdue and George E. Hughes* 81

Designing Tomorrow's Personal Plane, VII ..... *Ralph H. Upson* 84

New 2,500-HP. Engine Features Lightness, Accessibility 89

Plant Practice Highlights 91

For Better Design 115

Review of Patents ..... *A. Harry Crowell* 120

Aviation's Engineering Data Book 123

Aviation's Sketchbook of Design Detail 125

New Products and Practices 153

Aviation Maintenance

When Jones Says "My Radio's On the Blink" ..... *William A. Burroughs, III* 92

Safe Landings Demand Safe Tires ..... *A. C. Martin* 96

Aviation's Maintenance Notebook 98

Field Operations

Pilots: Know the Knack of Survival After Force-Down 101

Mobile Dual Refueler Affords High-Rate Service ..... *Thomas H. McConnell* 105

Tagging the Bases 106

Aviation Sales & Service

Wanted: Aircraft and Accessory Retailers ..... *Arthur S. Brown* 107

Selling Block Time Through Gift Certificates ..... *Robert L. Fli* 108

Military

Nobody Loves a Hot Pilot ..... *Charles A. Parker* 109

Finance

Engine-Stock Position Stronger Than Indicated ..... *Raymond L. Hoadley* 131

Recent Books 120

Side Slips 133

The Aviation News

National Aviation 135

Coming Up 135

Washington Windsock 138

Aviation Manufacturing 139

Transport Aviation 142

Aviation Abroad 147

Aviation Finance 149

Aviation People 151

George W. Pfeil, *Publisher* — Leslie E. Neville, *Editor*

John Foster, Jr. ..... *Managing Editor*
Herb Powell ..... *Associate Editor*
Edward E. Thorp ..... *Assistant Editor*
Irving Stone ..... *Assistant Editor*
Raymond Hoadley ..... *Financial Editor*
Erwin J. Bulban ..... *Editorial Assistant*
Chester S. Ricker ..... *Detroit Editor*
Scholer Bangs ..... *West Coast Editor*
Blaine Stubblefield ..... *Washington Editor*
Dallas Mallard ..... *Art Editor*
Donald Hogate ..... *Chief, Washington Bureau*

★ ★ ★

One Leave of Absence With Government Services

Charles F. McReynolds ..... *Lt. Col. Air Forces*
Jay P. AuWerter ..... *Major, Air Forces*
Randolph Hawthorne ..... *Major, Air Forces*
Kenneth D. Reynolds ..... *Lieutenant, Infantry*
David Baker ..... *Private, Air Forces*

★ ★ ★

Andrew B. Martin, *Sales Manager*

District Managers: New York, R. W. Martin; Philadelphia, D. Andrews; Cleveland, A. H. Bartsch; Detroit, C. W. Evaul; Chicago, James C. Anthony; St. Louis, W. E. Donnell; Los Angeles, R. N. Phelan; San Francisco, John Otterson.

McGRAW-HILL PUBLISHING CO., Inc. Publishing office 99-129 North Broadway, Albany, N. Y. Return postage guaranteed. Editorial and executive offices: 330 West 42nd Street, New York 18, N. Y. Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; National Press Bldg., Washington; 16 South Broad St., Philadelphia; Hanna Bldg., Cleveland; 2980 Penobscot Bldg., Detroit; Continental Bldg., St. Louis; 1427 Statler Bldg., Boston; Rhodes-Haverty Bldg., Atlanta; 621 S. Hope, Los Angeles; 738-9 Oliver Bldg., Pittsburgh. JAMES H. McGRAW, Founder and Honorary Chairman; JAMES H. McGRAW, Jr., President; CURTIS W. McGRAW, Senior Vice President and Treasurer; HOWARD EHRLICH, Vice President (for business operations); WILLARD CHEVALIER, Vice President (for editorial operations); JOSEPH A. GERARDI, Secretary; J. E. BLACKBURN, Jr., Vice President (for circulation operation), Aviation, 330 W. 42nd Street, New York. Published monthly, price 50c a copy, 50c in Canada. Allow at least ten days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York. Subscription rates—United States, Mexico and Central American Countries, $3.00 a year, $4.00 for two years, $5.00 for three years. Canada, $3.50 for one year, $5.00 for two years, $6.00 for three years, payable in Canadian currency at par. All other countries, $5.00 a year, $10.00 for three years. Please indicate position and company connection on all subscription orders. Entered as second class matter September 3, 1936, at the Post Office, Albany, N. Y., under the Act of March 3, 1879. Volume 45, Number 1. Printed in U. S. A. Cable Address, "McGrawhill, New York." Member A.B.C.

Copyright 1946, all rights reserved by McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y. The contents of this issue may not be reproduced without the permission of the copyright owner.

The following publication is combined with AVIATION: AERONAUTICAL ENGINEERING AIRCRAFT JOURNAL. All rights to this name are reserved by the McGraw-Hill Publishing Co. Aviation is indexed in Readers' Guide to Periodical Literature and in Industrial Arts Index.

10 WAYS TO SAVE IN AIRPORT CONSTRUCTION

Build for permanence and low maintenance with these Johns-Manville products

1. **J-M Asbestos Built-Up Roofs.** The *smooth-surfaced* roof that requires no mineral surfacing or periodic coating. Made of fireproof, rotproof asbestos felts, and built to give years of trouble-free service.
2. **J-M Asbestos Transite.** The ideal exterior siding. Attractive in appearance yet amazingly durable, it cannot burn, rot, rust or corrode—requires no painting or other preservative treatment. Made in large sheets, in flat and corrugated styles.
3. **J-M Rock Wool Insulation.** An "investment that pays for itself" in year-round comfort, fuel economy and added fire protection. Easily installed under roof areas and in building sidewalls.
4. **Transite Movable Walls.** Build with an eye to future expansion with these modern asbestos-cement office partitions. Sturdy and durable as a fixed wall, they can be erected practically overnight, taken down and re-located just as easily.
5. **J-M Asphalt Tile Flooring.** Inexpensive, attractive, resilient . . . withstands years of constant traffic with no upkeep except cleaning.
6. **J-M Acoustical Materials.** A "must" in every modern airport! Pioneers in this field, J-M has developed materials that effectively "soak up" disturbing noise—in the office, the control tower, wherever quiet is essential.
7. **J-M Asbestos Flexboard.** Save on interior and exterior walls with this versatile asbestos-cement building board. Fireproof and rotproof, yet can be worked with ordinary carpenter's tools.
8. **Transite Ducts.** Dependable asbestos-cement protection for underground electric cables. Fireproof, rustproof, rotproof, immune to electrolytic action.
9. **Transite Pressure Pipe.** This lightweight, easy-to-handle asbestos-cement pipe keeps installation costs low, assures efficient water transportation over the years.
10. **Transite Sewer Pipe.** Companion product to Transite Pressure Pipe, designed especially for sewage disposal lines. Strong and durable, yet light in weight and economical to install.

* * *

For further information about J-M materials for airports or other aviation uses, write Johns-Manville, 22 East 40th St., New York 16, N. Y.

Johns-Manville

87 YEARS OF SERVICE TO TRANSPORTATION

JOHNS-MANVILLE JM PRODUCTS

BRIEFING

"When Jones Says 'My Radio's On the Blink' " is not only the title of our article on page 92, it's proved to be the hundred-and-sixty-four-dollar question for the many operators who've felt "lost" when faced with a haywire tube set—a contingency which has summed up to cost them plenty. These losses can be turned into extra profits, though, by getting an eye for simple and sound trouble shooting (and this doesn't call for any intensive training) plus the right hookup with the right man when things get tough. William A. Burroughs of Aeronautical Radio Mfg. Co., who wrote our article, tells how to do it.

There are profitable articles in the Sales and Service section, too. On the all-important matter of distributor-dealer relationships, for example, Arthur Brown, Sales Manager of Scott Aviation Corp., gives on page 107 a needed warning on future trends, and shows that the long profits don't always grow where they're generally supposed to.

How hot pilots can cool off—so as to save their own lives and a lot of good usable airplanes—is graphically told (page 109) by Maj. Charles A. Parker, who analyzes the causes of all-too-frequent crashes when those military pilots used to thousands of horsepower climb into planes that definitely were not designed for combat. It's a must article for the Hot Shot Charlies who like to fly—and still stay alive.

Again Ralph Upson comes up with a most thought-provoking article in his outstanding series on "Designing Tomorrow's Personal Plane" (on page 84). This month he discusses a variety of design considerations—multiplanes, unusual lift devices, strange landing gear, even jets and rockets. It's plenty stimulating for the engineer who has resourcefulness and an open mind.

The war for world air routes is more than a single-phase battle between lines, for it's already complicated on the various home grounds by deep seated philosophies—specifically those between free enterprise and socialization. Already the "nationalizers" have a strong grip in England and Canada; now the idea of government-owned airlines has become law in Australia. But the "Down Under" airlines haven't given up the ghost, and what they're doing is clearly revealed (page 40) in the intriguing article by Aviation's Australian correspondent.

Authors of first two articles in our special jet propulsion-rocket section. At left is MAJ. R. C. SCHULTE, project officer on turbojet and gas turbine development at AAF headquarters since 1942, who wrote the Design Analysis of the GE I-16—an unusually interesting article in that it gives, in addition to the design details, the fascinating background on the creation of this engine. At right is DALE D. STREID, brilliant young engineer who headed development of GE's I-40 Superjet, and author of the first Design Analysis on that engine. In addition to these two outstanding articles, Managing Editor Foster has prepared an analysis of the Westinghouse 19-B Yankee, first all-American design and first American axial flow turbojet. Rounding out this section is a detailed study of the Gloster Meteor, world's fastest plane (at least up to press time); thorough-going study of JATO by Aerojet's Dr. Martin Summerfield, and details of the Walter Rocket engine, which powered the Me-163B, written by Roy Healy, one of the country's top rocket experts. (See pages 43 through 80.)

Down the Years in AVIATION'S Log

25 Yr. Ago (1921)—Successful termination of Pulitzer and California Air Races without fatalities impresses public with safety of flying. . . . Sadi Lecointe sets 4 km. (2½ mi.) record at 194.5 mph. . . . Army develops gyro-stabilized aero camera. . . . W. W. Hosp of N. Y. uses airplane as first flying sample room. . . . Post Office orders lighting of Chicago-Cheyenne airway. . . . Argentine inaugurates airmail on 1,500 mi. route. . . . Mexico City stages first National Air Show. . . . Maj. H. H. Arnold reports 9th Air Force flew 476,085 mi. on forest fire patrol in year. . . . Engineering dept. at Carlstrom Field reports engine overhaul period has been increased from 50 to 250 hr.

15 Yr. Ago (1931)—Ford Trimotor plane makes record by carrying 4,400 lb. at 164 mph. . . . Of 13,000 licensed U. S. pilots, 600 are in airline category. . . . Check shows 92% of 1930 flight students obtained licenses. . . . Asst. Secy. of War announces that "dramatic and comprehensive" public tests along the Atlantic seaboard, using 500 planes. . . . PAA, Imperial Airways, and French CGA hold joint conference regarding projected U.S.-Bermuda-Azores-Lisbon route. . . . ACCA proposes uniform aircraft storage rates. . . . *Graf Zeppelin* flew 144,275 mi. and carried 2,200,000 lb. freight during 1930. . . . Mrs. V. Bruce, with only 100 hr. solo experience, flies 13,000-mi. London-Tokyo run.

10 Yr. Ago (1936)—AA takes delivery of first Douglas DC-3 sleeper. . . . Air Corps uses Kellett Autogiro. . . . Airlines leave ACCA to form ATA. . . . UAL asks for bids on 40-pass. transports. . . . First maintenance meeting of airline men held at Miami. . . . Hawaii's Inter-Island Airways reports carrying 60,000 passengers a total of 1,500,000 mi. without accident during '35. . . . PCA cuts certain of its passenger rates to less than Pullman fares. . . . Air Force orders 100 Northrop attack planes, 90 Douglas bombers, and 13 Boeing 299s (B-17 prototype).

An Open Letter on Policy

Regarding KOLLSMAN Products and the new

Scout

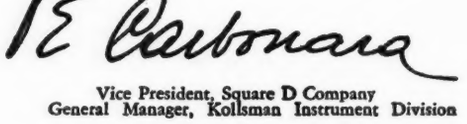
Instruments

Kollsman intends to continue the development and manufacture of instruments second to none in precision and reliability for the Military Forces and Airlines of the United States. This is the field where the ultimate is required, expected and demanded. We have the vision, the facilities and the staff to provide it.

This same Kollsman standard of quality guides us also in the manufacture of instruments for private aircraft. If personal airplanes are to be built and used in large numbers, and if the industry is to grow as it should — and as it can — certain quality standards must be maintained. The airplane is not the vehicle with which to experiment in order to determine how cheap an instrument one can get by with. An inaccurate or unreliable instrument is worse than none at all. Quality will never be subordinated to price in any Kollsman instrument.

Our new Scout line of instruments for personal airplanes — at prices well within the reach of the private flyer — was made possible by re-designing the standard airline and military instruments to the performance requirements of the private plane. Their ruggedness, accuracy and trustworthiness can be important aids to the safety and utility of private aircraft.

This, then, is our policy for the future in the manufacture of aircraft instruments. We believe it will contribute much to the healthy growth of the industry.



Vice President, Square D Company
General Manager, Kollsman Instrument Division

KOLLSMAN INSTRUMENT DIVISION OF SQUARE D COMPANY, 80-08 45th AVENUE, ELMHURST, N. Y.

NEW!

PLOMB *Flare Nut* WRENCHES

Many exclusive features give these wrenches far greater utility and life than ordinary ones. Scientifically designed with a constant-strength section around the box end, they are FULLY GUARANTEED to take the torque on any flare nut job.

Extra deep heads increase gripping surface on nuts, prevent wrench from slipping off or chewing soft metal. Generous size openings make insertion over tubing easy. NINE POINTS insure positive grip. Strong but thin walls provide maximum clearance.

Plomb Flare Nut Wrenches will save you time and money on all types of tubing work—automotive, aviation, refrigeration, air conditioning. Order them from your Plomb distributor today, or send for complete information to the Plomb Tool Co., 2221D Santa Fe Ave., Los Angeles 54, Calif.

partners in creating

● Even K & E has never devised an instrument that would make it unnecessary to *think*. But we have spent 78 years designing and producing things that make it easier to *act* after thinking . . . drafting instruments and related materials that give the engineering hand and eye almost the same precision as the engineering brain. How well K & E products serve as partners in creating is shown by the reliance placed in them by engineers and draftsmen throughout the world.

So widely is this equipment used that practically every great American engineering project has been completed with the help of K & E. Could you wish any surer guidance than this in the selection of your own instruments and materials?

To make measurements with the greatest ease and the least chance of error, choose a WYTEFACE* steel tape or tape rule of the type made especially for your work. Their jet black markings against their white background are as easy to read in the brightest glare as in the dimmest light. They are readily kept clean, are rust-resisting and hard to kink. For full information about them write to your nearest K & E Distributor or to Keuffel & Esser Co., Hoboken, N. J.

*Trade Mark *WYTEFACE Steel Tapes and Tape Rules are protected by U. S. Pat. 2,089,209*

. . . the world's finest railroads
. . . most efficient plants
K+E
Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules, Measuring Tapes.
KEUFFEL & ESSER CO.
EST. 1867
NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO
• LOS ANGELES • MONTREAL

"My War Job's Done..

SO HERE I COME!"

NEW Mobilgas AIRCRAFT

GIVES FLYING HORSEPOWER

Mobilgas AIRCRAFT

IT'S HERE *for all planes*—the same super power that boosted U. S. fighter-bomber performance—in a great *new* Mobilgas Aircraft!

It's *Flying Horsepower*—a new kind of gasoline performance that gives commercial and private planes faster take-offs, climbs, speeds.

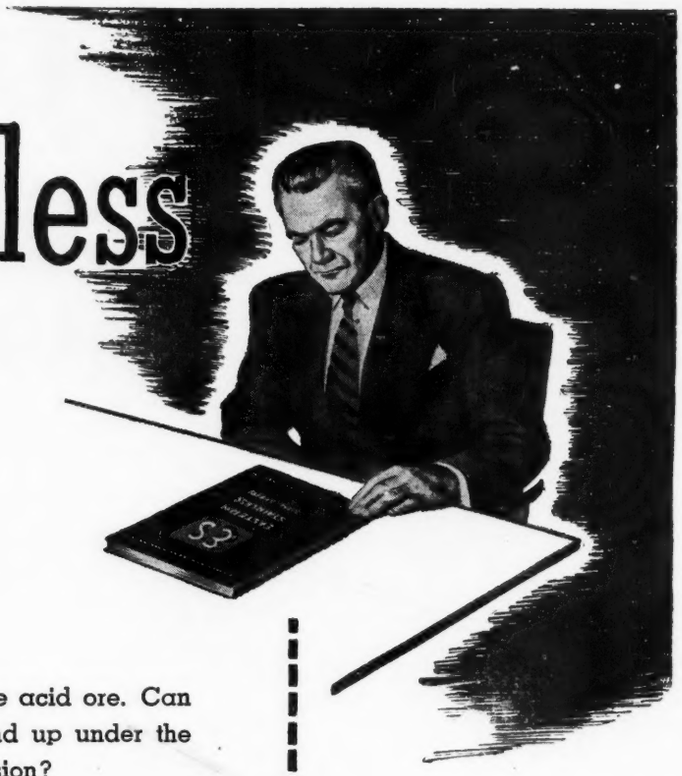
Flying Horsepower climaxes 13 years of Socony-Vacuum research—is the result of world's greatest catalytic cracking program.

Get NEW Mobilgas Aircraft and you get the greatest flight power you've ever known . . . *Flying Horsepower!*

SOCONY-VACUUM OIL CO., INC., 26 Broadway, New York 4, N. Y., and Affiliates: Magnolia Petroleum Co., General Petroleum Corp. of California

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.S.T.—NBC

which Stainless *shall I use?*



MINE CARS?

Our mine cars handle a moist abrasive acid ore. Can we get a Stainless Steel that will stand up under the abrasion, and also resist the acid corrosion?

HEAT TREATING EQUIPMENT?

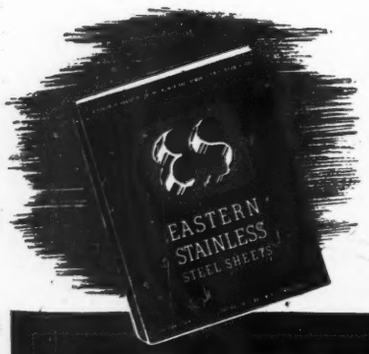
Our heat treating furnaces operate up to 1,500° F. Can we replace the hoods with Stainless? If so, which grade do you suggest?

CHEMICALS?

We are thinking of using Stainless Steel sheets for the lining of our dye vats. What grade and finish of Stainless Steel would you recommend?

MARINE HARDWARE?

Please send us your recommendation for the best grade of Stainless Steel for use in marine hardware, including rudders and fins.



Such questions on Stainless Steel selection are typical of questions which Eastern Stainless representatives answer every day. Eastern Stainless offers *all* the stainless grades you need for specialized applications of stainless steel sheet and plate. Consult Eastern on your selection problem.

Many of the answers are in the 96-page "Eastern Stainless Steel Sheet" handbook which, because of the great demand for copies, is now in its second printing. Write for your copy on your company letterhead.

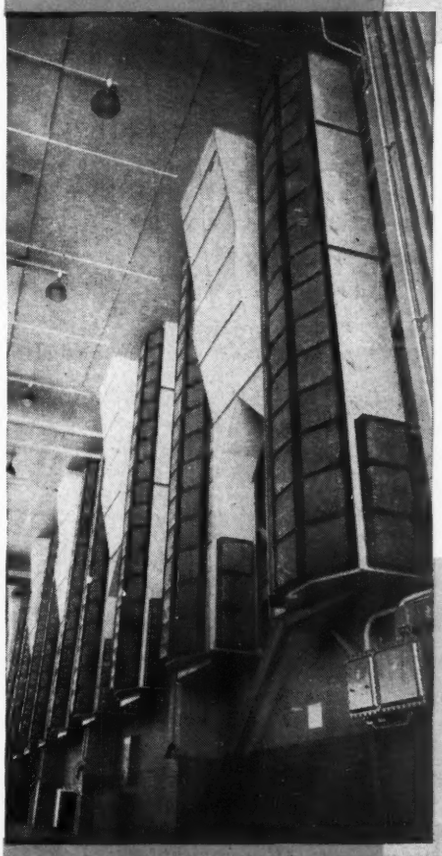
JMLCO. E-A1

ask Eastern for the answer when Stainless is the question

EASTERN STAINLESS
STEEL CORPORATION
BALTIMORE 3, MARYLAND · Distributors' stock available in most areas
CHICAGO · CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEWARK · PHILADELPHIA

AIRCRAFT *Finishing* SYSTEMS

Above: One of several batteries of Mahon Hydro-Filter Units for removing over-spray from the air before recirculation. At right: The exhaust side of Mahon enclosure for spray painting completely assembled four-engined bombers.



Above: Filtered Air Supply Units on the air supply side of Mahon enclosure for spray painting four-engined bombers. At right: Typical Mahon Finishing System for Airplane Parts and Partial Assemblies.

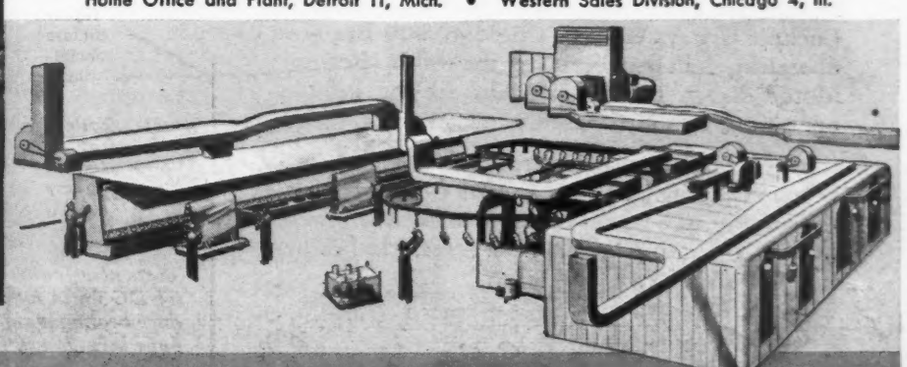
. . . for Spray Painting Completely Assembled Airplanes or Smaller Assemblies and Parts

Over twenty-five years of experience in every industry where Spray Painting is an important production operation, has endowed the Mahon organization with a wealth of technical knowledge and "know how" which is responsible for the outstanding success of Mahon Finishing Systems all over the world. Mahon engineers are prepared to analyze your Finishing problem and engineer, build, and install a complete Finishing System which will meet your particular painting production requirements with greatest economy and maximum efficiency—whether it be for parts, partial assemblies or completely assembled airplanes. Completely assembled four-engined bombers were spray painted in Mahon equipped enclosures during the war. Consultation with Mahon engineers will not place you under obligation.

Address correspondence to INDUSTRIAL EQUIPMENT DIVISION

THE R. C. MAHON COMPANY

Home Office and Plant, Detroit 11, Mich. • Western Sales Division, Chicago 4, Ill.



MAHON

Manufacturers of Complete Finishing Systems including: Metal Cleaning, Annealing, Spray Painting and Drying equipment

FLYING for the A.T.C., hundreds of Douglas 40-passenger C-54's make round-the-world trips every week. On flights like these, passengers expect the *comfort* of dependable heat—they *get* it by the use of Janitrol Whirling Flame Aircraft Heaters.

Heat for the cabin is provided by two 100,000 Btu Janitrols which can be operated together or as separate units depending upon requirements. Cockpit is warmed by a single 40,000 Btu unit operating independently of the cabin heaters. Motor driven blower supplies air for ground operation; ram air is used when in flight.

More than 3000 Janitrol combustion type heaters were installed in Douglas C-54's for wartime flying. The proven performance of these heaters, operating under the severest kind of flying conditions, leads Douglas to specify Janitrol equipment for cabin heating and thermal anti-icing applications on the new C-74 Globemaster.

Compactness and light weight saves valuable pay-load capacity. Maintenance costs are low—1,000 hours of heater operation without service is not unusual. Inspection and service are easy because of the accessibility of all Janitrol component parts.

Complete Janitrol Heating Package for DC-3 Planes Will Soon Be Available

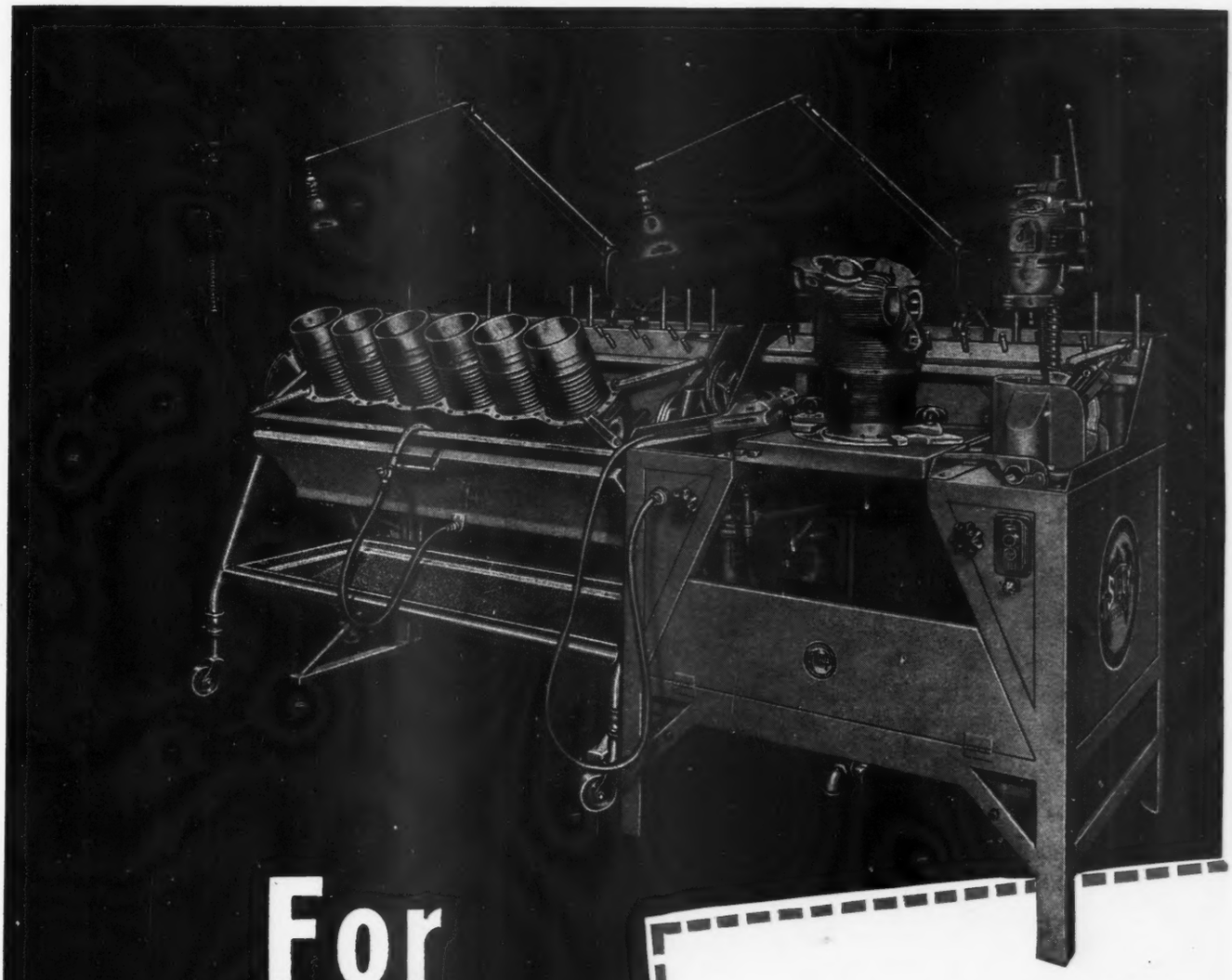
Complete compact heating systems with all necessary controls—includes blower for ground operation.

By utilizing existing DC-3 duct work, installations can be made quickly and economically.

These new Janitrol systems were designed especially for DC-3's, to improve passenger comfort and to reduce heating maintenance costs. All component parts have been proven in military and transport service.

Janitrol

AIRCRAFT HEATER DIVISION • SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO



For Speedup With Precision

Production and maintenance schedules can be stepped up with this wet valve seat grinding machine on In-line and Radial Aircraft Motors because accuracy and dependability are built right into the machine.

SIOUX

AIRCRAFT
wet valve seat
GRINDING MACHINE
for
IN-LINE and RADIAL MOTORS

Write at once for full details

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

Superior Engineering . . . basis of Collins quality leadership

Above all, the Collins Radio Company is an engineering outfit. 4.4% of the organization's entire personnel are graduate engineers.

They came to Collins because the Collins progressiveness and quality standards are their own ideals, and brought with them successful experience in both radio and allied electronic fields. They are the nucleus of the organization, from management on through.

These men determine and uphold the character of Collins radio communication equipment from inception, through all stages of research, design, production, quality control, field test and field service.

Aviation can look with confidence to Collins for the best available performance in air borne and ground station radio communication equipment. We will welcome an opportunity to consult you regarding your requirements.

COLLINS RADIO COMPANY
Cedar Rapids, Iowa
11 W. 42nd Street, New York 18, N. Y.

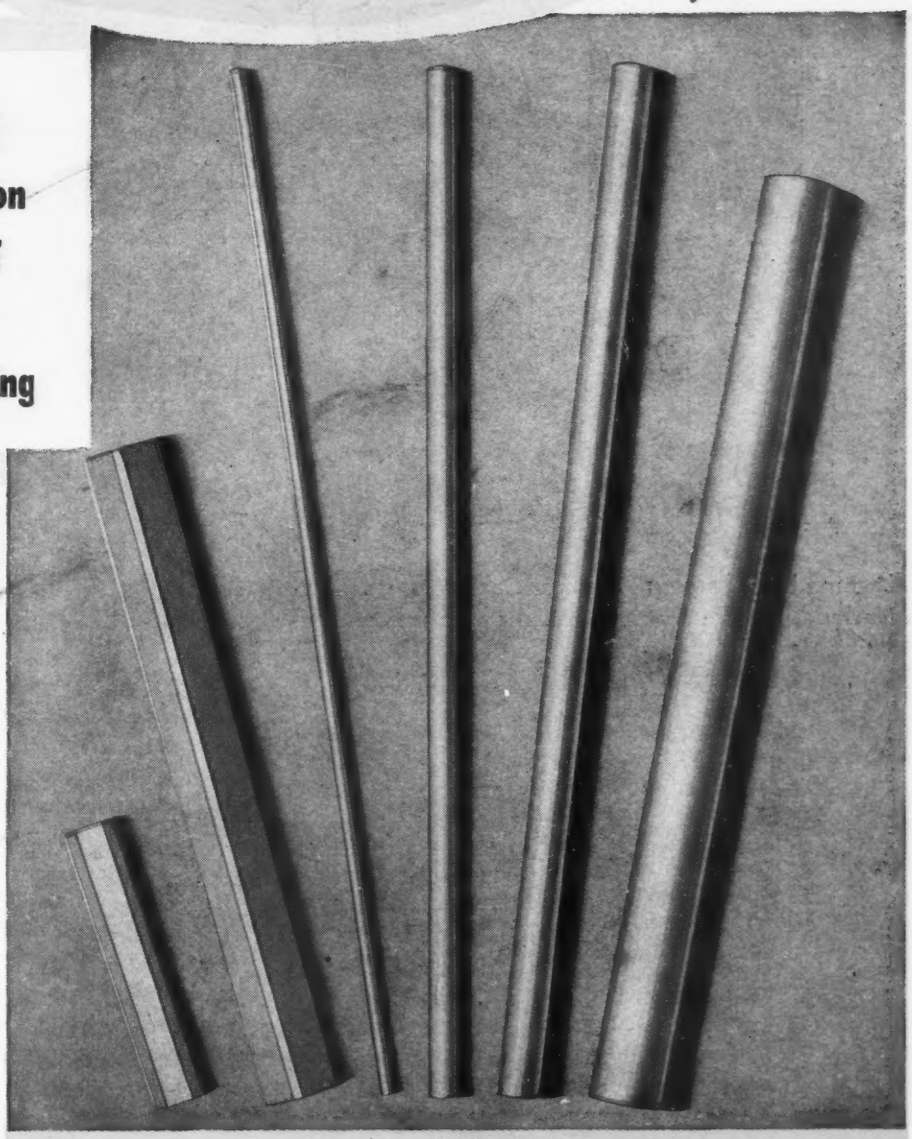
IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

AGALOY

Corrosion Resistant TUBING

You may be sure of proper surface condition *INSIDE* and *OUTSIDE* when you specify AGALOY Stainless Tubing



- **High strength**
- **Heat and corrosion resistant**
- **Fabricates readily**

AGALOY stainless tubing is made in cold drawn welded or seamless construction in sizes to ⅝-inch outside diameter. Write for catalog describing Agaloy's complete line of stainless, carbon and alloy tubing.

MONEL metal 18-8 STAINLESS

AGALOY TUBING COMPANY • MILL: SPRINGFIELD, OHIO

EXECUTIVE AND SALES OFFICES: 1027 NEWARK AVE., ELIZABETH 3, N. J. • CHICAGO OFFICE: 221 NORTH LA SALLE ST., CHICAGO 1, ILLINOIS

He's going to SOUTHERN AIRCRAFT CORPORATION, down in Garland, for the acceptance flight on our new company airplane. With room for five or six people, it sure looks like a good thing.

Executive travel has taken to the air, and we need that plane of Southern's to keep us ahead of competition. Jim says those two engines and variable pitch props guarantee top performance. He likes the tricycle landing gear, too . . . and even with my limited knowledge, I can see from the details Southern sent us, there isn't any finer plane construction — their war experience with Navy fighting planes, proves that. Then too, gyroscopic instruments and complete radio equipment will make weather flving a breeze.

What I particularly like, is the way the cabin is designed. Did you notice how roomy it is? And that fold-away desk . . . why we'll have our conference reports under way before Jim levels off on the homeward flight.

Anyway, get that reservation, and while you're at it, you might as well revise the schedule for the regional sales meetings . . . it won't take half the time now. And, oh yes, wire Southern . . . Jim is coming.

Southern
AIRCRAFT CORPORATION
PLANT IN GARLAND, DALLAS COUNTY, TEXAS

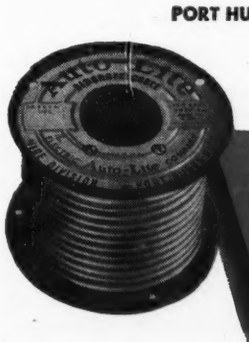
Hotter than a firecracker—

FIRST plane to combine the conventional engine and propeller with jet propulsion is the Ryan Fireball. The builder tells us short take-off, fast climb and great maneuverability come partly from the fact that nothing but the best in equipment is used.

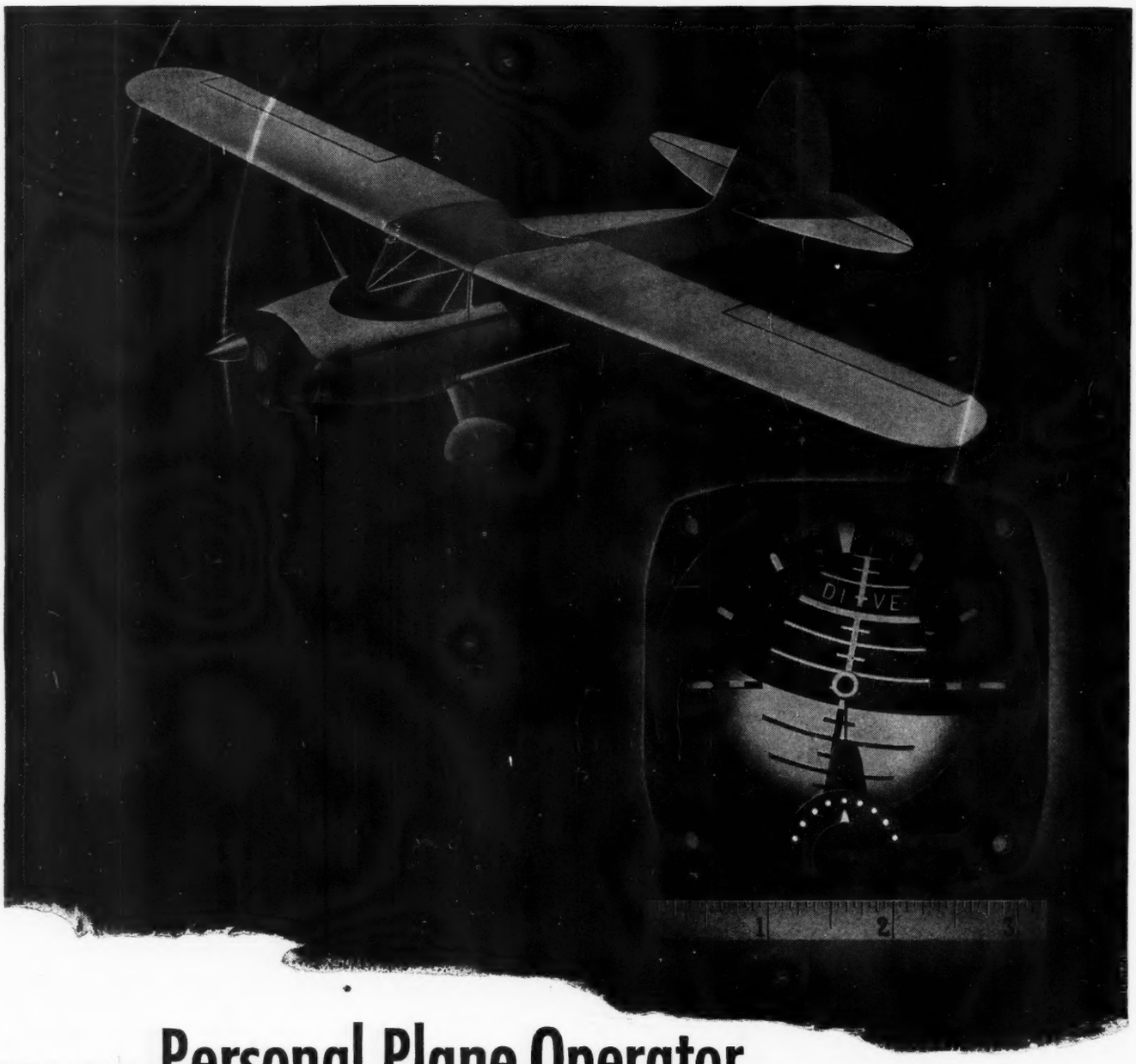
Its low tension wire, for example, was built by Auto-Lite. This same war-tested wire is now being made available to builders of peace-time planes. Like all other Auto-Lite products, it is built for complete dependability. A new booklet listing the major parts built by Auto-Lite in its 22 great plants is just off the press. A copy will be mailed on request.

PORT HURON, MICHIGAN **THE ELECTRIC AUTO-LITE COMPANY** SARNIA, ONTARIO

TUNE IN THE AUTO-LITE RADIO SHOW STARRING DICK HAYMES
EVERY SATURDAY NIGHT, 8:00 P.M.—E.S.T. ON CBS



Aircraft AUTO-LITE WIRE & CABLE



FOR THE Personal Plane Operator...

AN IMPORTANT NEW PRIMARY INSTRUMENT

An air driven Attitude Gyro, built under the same high standards as the well-known Sperry Directional Gyro and Gyro-Horizon, has been developed by Sperry Research and is now available. This instrument can be used on any airplane where vacuum operated instruments are normally required.

The same "Four Freedoms in Flight" which Sperry's electric Attitude Gyro is giving to pilots of military and transport aircraft—freedom from caging, tumbling, misinterpretation, fatigue—are now at the fingertips of the personal plane operator.

Pattern indication (the same by day or night) gives the pilot a quick, visual picture of his attitude at all times... continuously, at any flight angle, regardless of visibility or turbulence.

Sperry's Model F-3 Attitude Gyro is of small standard size, light weight (2¼ lbs.) and low initial cost. Its simplicity of construction means reduced maintenance cost.

Write our Aeronautical Department for further information.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

Division of the Sperry Corporation

LOS ANGELES • SAN FRANCISCO • SEATTLE • NEW ORLEANS
CLEVELAND • BROOKLYN • HONOLULU

GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

Send for Bulletin No. 55

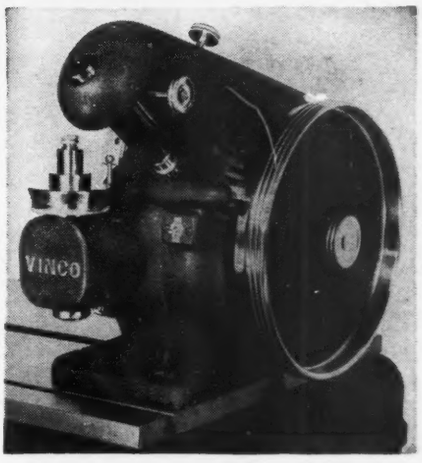
30 Times MORE ACCURATE

What does that mean to you? It means that this proven accuracy is available to you for the inspection of gear teeth, master index plate notches, splines, cams and any other form of angular spacing. It means that final assemblies involving gears, cams, splines, etc., will be subject to less scrappage, because angular spacing errors will have been found and corrected.

Vinco guarantees the OPTICAL MASTER INSPECTION DIVIDING HEAD to be accurate within two seconds of arc; the master disk graduations to be spaced to an accuracy within ONE SECOND of arc; and the ball bearing spindle runout to be within TWENTY-FIVE MILLIONTHS of an inch, total indicator reading (the majority of spindles have less than fifteen millionths runout).

The fact that the VINCO OPTICAL MASTER INSPECTION DIVIDING HEAD has become firmly established throughout industry in such a short time is proof of its dependability and industrial necessity. The following pages cite one of many actual cases where the VINCO OPTICAL MASTER DIVIDING HEAD played a vital role in the production of a toothed part.

Below is the dividing head proper, showing the micrometer, scope, and hand wheel.



MILLIONTHS OF AN INCH FOR SALE BY VINCO

REG. U. S. PAT. OFF.

VINCO CORPORATION, 8865 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN; SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Rolling Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts.

They Came to

Check These Against Your Present Needs

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Roller Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts.

VINCO

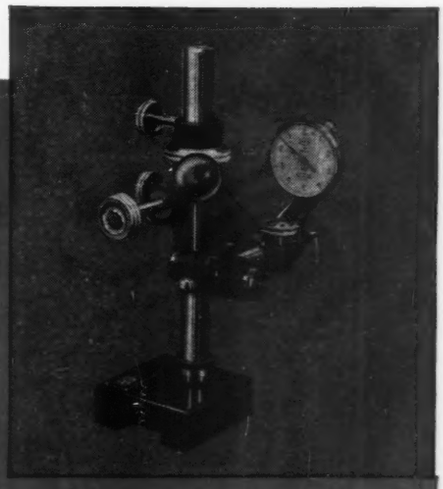
BECAUSE THEY WERE STUMPED BY A REAL "TOUGHY"

It wasn't unusual! This group of production engineers, representing a large eastern manufacturer, had used our precision production service before and were well acquainted with Vinco methods and Vinco results.

Their request was not an ordinary one however! We were asked to produce, in quantity, mating toothed parts with 18 slots, each slot .017″ in width with a tolerance of .0003″ and a root diameter held to a uniformity of .0001″.

These parts were produced exactly as specified and were delivered on time and in quantities over and above specified requirements. We cite this one instance only because it is informative. Our long experience in the production of precision instruments and finely finished gages has given us a decided edge on precision production methods and techniques. Equipment and machines of our own design and make, in the capable hands of highly skilled operators, an engineering force thoroughly grounded in every phase of precision design and construction and a sales organization made up of men who combine a full engineering background with a wide and intimate knowledge of the trends and developments in the industrial field are all valid reasons for a further inquiry regarding this important phase of modern production.

Precision parts by Vinco meet your specifications. Give us the chance to prove it.



The Vinco Standard Indicator Surface Gage

Features of this gage include a .0001″ custom built, full jeweled, dial indicator—differential adjusting screw for final settings—1½″ to 12″ work height range—full 360 degree swing of indicator head—readings can be taken on upper or lower surfaces.

Extreme accuracy and flexibility of operation all combine to make this standard indicator gage practically indispensable wherever rapid and close inspection of surfaces is required. (Incidentally, it was used regularly for checking the job mentioned above.) We designed these indicator gages for use with the Vinco Optical Master Inspection Dividing Head, but because of increasing requests they are now offered for general sale.

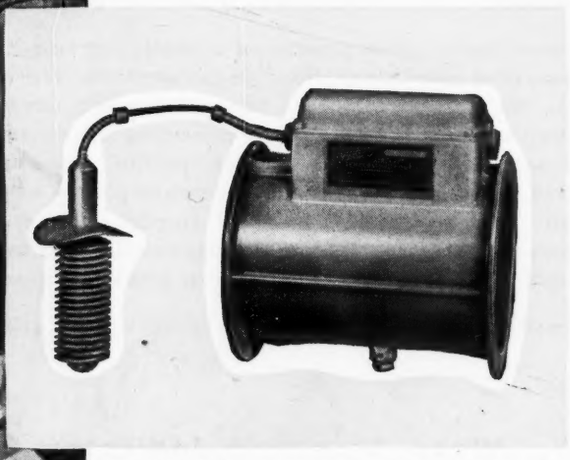
Vinco Universal Dividing Head

Developed by Vinco to handle light machining or grinding, this universal dividing head played a vital part in the manufacture of the "Toughy". A ratio of 1440 to 1 between handle and work spindle provides an extremely high degree of spacing accuracy, even when using standard commercial dividing head plates.

The dividing head can be mounted either vertically or horizontally. It features a large diameter spindle mounted in a double row of Vinco designed ball bearings, a tapered spindle nose for work adaptors, a face plate of 11″ diameter, a graduated dial on the spindle for initial settings, an auxiliary resetting dial and a 11.459″ pitch diameter helical gear index plate with 360 accurately spaced teeth.

a Good Mixer

THAT MAKES FRIENDS FOR AIRLINES



No. 707 Sylphon Temperature Regulator consists of a thermostatically controlled valve that mixes hot air from the engine with cold air from the air scoop in predetermined proportions.

● It's June in January for the passengers and crew of many a modern airliner . . . principally because a Sylphon Aircraft Temperature Regulator is constantly on the job mixing cold air with hot, in just the right proportions for customer comfort.

Yet this is only one of many Sylphon instruments designed by specialists to win friends and increase profits for commercial aviation. Others include: liquid cooled engine thermostats, fuel pressure regulating valves, thermostatic shutter releases, shaft seals, and bellows assemblies for super-charger, carburetor, fuel injector controls, etc. Whether you're building planes or flying them, one or more of these devices will help you achieve greater operating efficiency and economy. Our engineers will be glad to work with you without obligation. Write today for Bulletin No. AA-822 giving complete information.

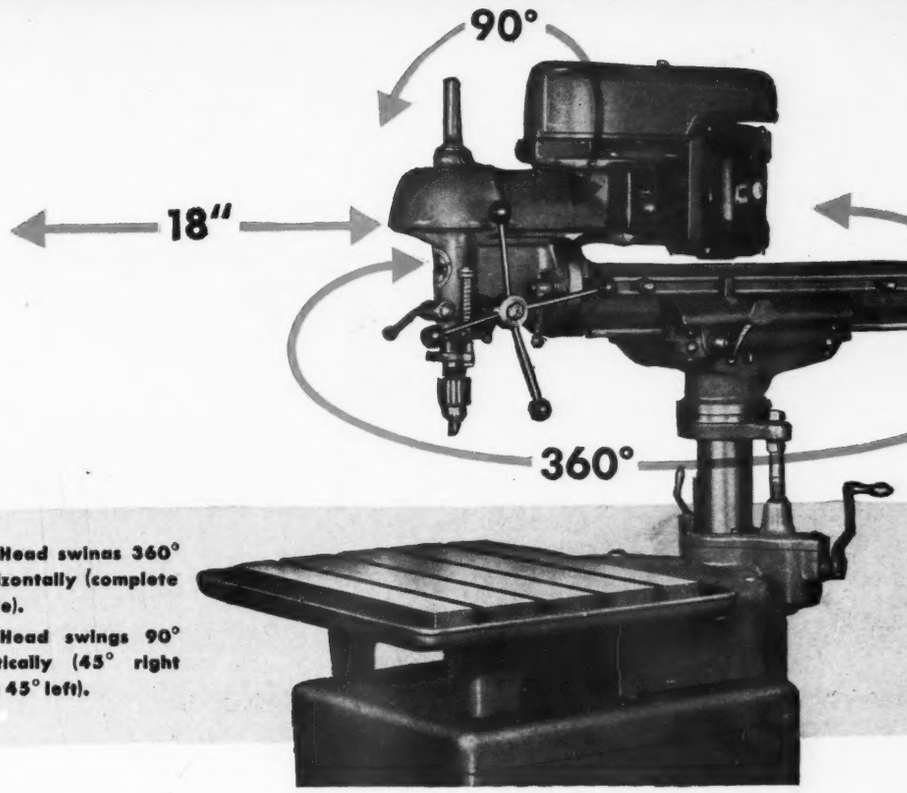
FULTON SYLPHON

Temperature Controls • Bellows ••• Bellows Assemblies

THE FULTON SYLPHON COMPANY • KNOXVILLE 4, TENNESSEE

Canadian Representatives, Darling Brothers, Montreal

Get in the SWING and cut costs with Walker-Turner RADIAL DRILLS



. . . Head swings 360° horizontally (complete circle).

. . . Head swings 90° vertically (45° right and 45° left).

. . . Gliding ram travels 18".

. . . Drills to center of 62" circle.

. . . 16 spindle speeds from 160 to 8300 r.p.m.

IF you're drilling, tapping or reaming holes up to ½" in large workpieces . . . Walker-Turner Radial Drills are the answer for faster production and lower cost per piece.

Within their drilling capacity, these versatile machines have a greater range than standard drill presses . . . are easier to operate and simpler to control than heavy radials. Low first cost, low upkeep and low power consumption are other important advantages of Walker-Turner Radial Drills.

PRICE: $352.50
less base and motor
(Slightly higher west of Rockies and in Canada)

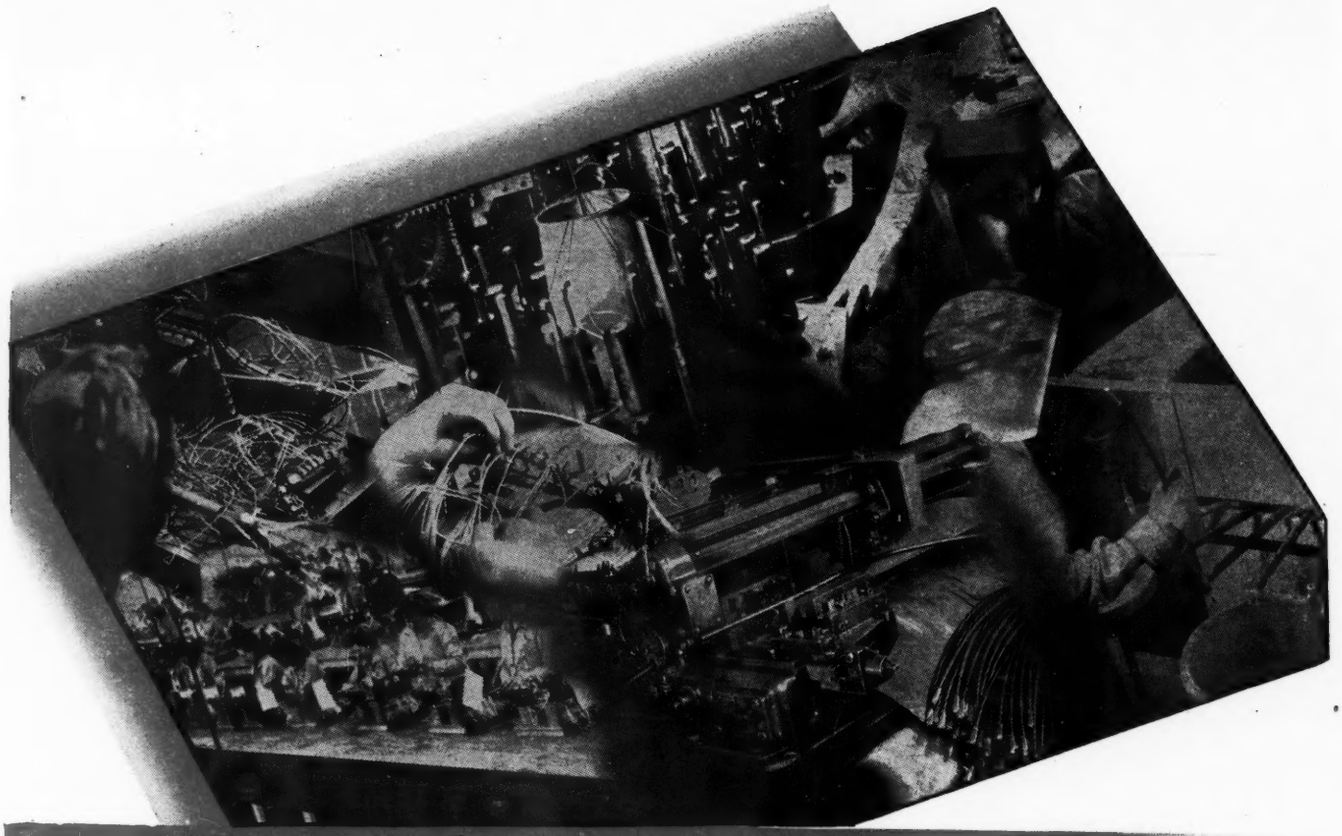
For complete description, send for our latest catalog.

Walker-Turner Company, Inc., Plainfield, N. J.

walker-Turner
COMPANY, INC.
PLAINFIELD, N.J.
U.S.A.

MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS



ENGINEERED CABLE ASSEMBLIES at a fixed production cost to you

If your product requires WIRING HARNESSES...CABLE ASSEMBLIES...BONDING JUMPERS... CABLE or TERMINALS—you'll find that a lower cost of manufacturing, at a fixed production cost to you, is one of many advantages Whitaker offers you.

In turning the production of your wiring requirements over to us you are assured quality merchandise made to the most exacting specifications. When your men install the completed assemblies they will find every lead and every terminal properly positioned for the right connection. The economies gained will be big factors in enabling you to lower your cost of manufacturing.

In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable products . . . Write for latest catalog, and complete information.

Whitaker Can Wire It

WHITAKER CABLE CORPORATION

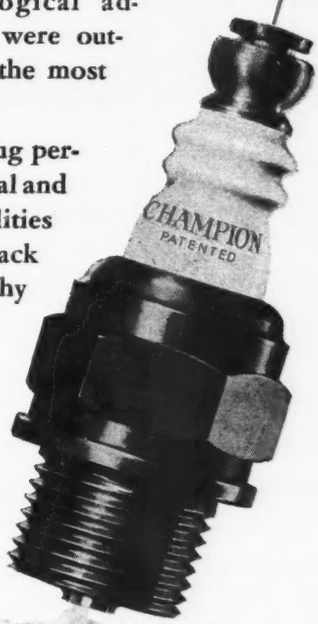
General Offices: 1301 Burlington Avenue, Kansas City 16, Missouri
Factories: Kansas City, Mo.• St. Joseph, Mo.• Philadelphia • Oakland

Type of 6-engine Clipper Pan American World Airways will place in service in the future.

New Horizons... IN SPARK PLUG PERFORMANCE

Wartime necessity produced technological advances in Champion Spark Plugs which were outstandingly evident in the performance of the most advanced military aircraft engines.

Today, there are new horizons in spark plug performance for every aircraft engine, commercial and private. The unequalled manufacturing facilities and experience exclusive to Champion are back of every Champion Spark Plug. That's why it will pay you to insist on dependable Champions. They are available in sizes and types for every engine and insure maximum performance and dependability under every operating condition. Install Champions and fly with confidence. Champion Spark Plug Company, Toledo 1, Ohio.



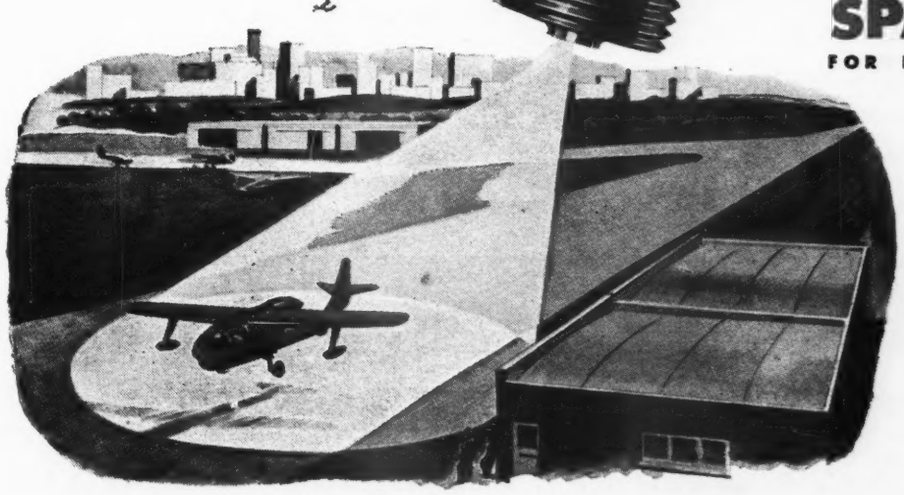
C26—Unshielded

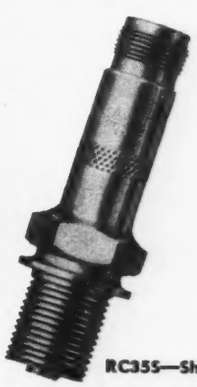
DEPENDABLE

CHAMPION

SPARK PLUGS

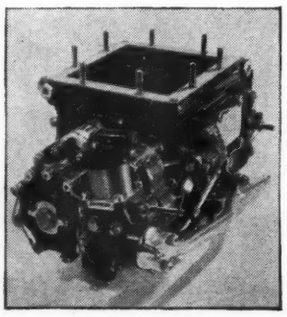
FOR EVERY AIRCRAFT ENGINE





RC35S—Shielded Type

19,400 Hours of Uninterrupted Service . . . on the Route of the Flagships



American Airlines' records show that the Holley Carburetor serial #78 pictured in the inset at left, has given 19,400 hours of dependable, trouble-free service. It has flown some 3,104,000 miles and is still in service. In these hundreds of trips this carburetor metered approximately 875,000 gallons of high octane gasoline to the engine it served. Almost half a century of research and scientific manufacture has built stamina and dependability into every Holley Carburetor. That's why commercial airlines look to Holley for carburetor leadership and dependability of performance!

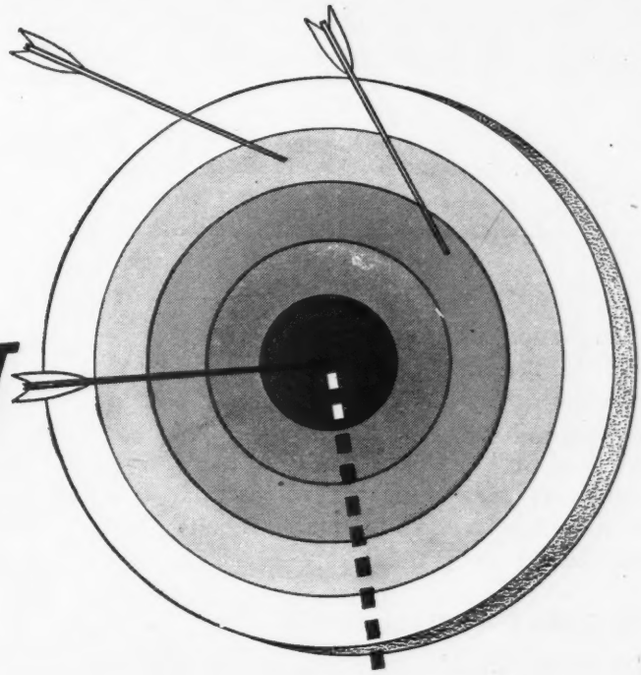
HOLLEY CARBURETOR COMPANY
5930 VANCOUVER AVE., DETROIT 4, MICHIGAN

HOLLEY

AIRCRAFT, AUTOMOTIVE, MARINE

CARBURETORS AND ACCESSORIES

YOU NAME IT



We at Lawson's,

along with many in associated industries, call our work precision manufacture. But there's more to it! Far more to it! Our craftsmen and engineers are actually artists in every sense of the word, proud of the top-notch quality of their work, proud of their ability to produce in huge quantities precision manufacture. Combine quality, ability, and experience — the only name we can think of with **guaranteed results** *is Lawson.*

PRECISION Lawson

Hollow spindle for radar equipment. These spindles are ground all over, including the thread, and have diameters held to .0002".

LAWSON MACHINE and TOOL CO.
120 MOUNTAIN AVENUE, MALDEN 48, MASS.

NO OTHER PUMP *So Small*
CAN MATCH THESE RATINGS

CAPACITIES:
¼ GPM to 3 GPM
PRESSURES:
0 to 1000 PSI for oil
0 to 200 PSI for water
SPEEDS:
Up to 3000 RPM

This McIntyre Series 100 *precision* gear-type pump offers you the advantages of accurate performance in the smallest space for pressure delivery of fluids — even corrosive liquids. Capacity is determined by the width of easily-changed center plates and spur gears. Made to match the characteristics of the fluids handled. Adaptable for all popular drives.

POSSIBLE APPLICATIONS

Its simple, trouble-free design makes this tiny pump a natural for washing machines . . . dish washers . . . machinery control mechanisms . . . pressure lubrication . . . circulation of coolants, cutting oils and other fluids . . . light aircraft hydraulics.

McINTYRE PRECISION

The light-band trade-mark on every McIntyre Pump and Fluid Motor assures you of the ultimate in precision . . . obtained from machining methods *capable of making surfaces flat to one light band . . . of holding vital dimensions to a plus or minus tolerance of .000025".*

CHECK THE FACTS

For complete engineering data on McIntyre Series 100 *precision* pumps, write for Bulletin 425, describing your intended use. The McIntyre Co., 15 Riverdale Avenue, Newton 58, Massachusetts.

THE McINTYRE CO.
(FORMERLY ZENITH ASSOCIATES)
PUMPS AND FLUID MOTORS

THE ULTIMATE IN PRECISION — *IDENTIFIED BY THE LIGHT BAND*

AIRTRON

One of the War's unusual achievements in new materials

Vitally important to the Superfortress flying over Tokyo was the need for keeping windows from fogging. Working with aircraft manufacturers and Air Force engineers, Arrowhead research men developed the defroster and cabin heater ducts used in the B-29, the P-51 and other airplanes. Where AIRTRON has been used no lives or equipment have been lost as a result of air ducting failures.

AIRTRON, fabricated of glass cloth and rubber, is flexible, withstands extremes in heat and cold, possesses high insulating qualities and other favorable characteristics. It will replace sheet metal ducts, ordinary pipe and hose in thousands of applications. It will be used in containers, tanks, pumps, etc.; in food, beverage and chemical industries where corrosion is a factor. The heating, ventilating and air-conditioning of your future planes, trains, automobiles, buses and homes will use a great deal of AIRTRON—the new versatile material.

Arrowhead research men are now working with a number of manufacturers who are desirous of employing AIRTRON in their products and processes.

Tell us what you make and Arrowhead engineers will gladly make available information concerning the characteristics suitable to your needs. Write us today.

*Trademark Registered

NATIONAL OIL AND FLUID SEALS

WHEREVER SHAFTS MOVE, THERE'S A NATIONAL OIL SEAL TO RETAIN THE LUBRICANT

ARROWHEAD RUBBER COMPANY

2244 EAST 37th STREET • LOS ANGELES 11, CALIFORNIA

Division of National Motor Bearing Co., Inc.

ENGINEERS and MANUFACTURERS of MECHANICAL RUBBER PRODUCTS

In addition to AIRTRON products the Arrowhead Rubber Company manufactures a wide selection of molded, extruded, and hand-built items. You will like doing business with Arrowhead—four-time winner of the Army-Navy E for efficient production. Consult with us on your rubber problems.

PCA

THE CAPITAL AIRLINE

EFFICIENT MAINTENANCE FOR PCA CAPITALINERS

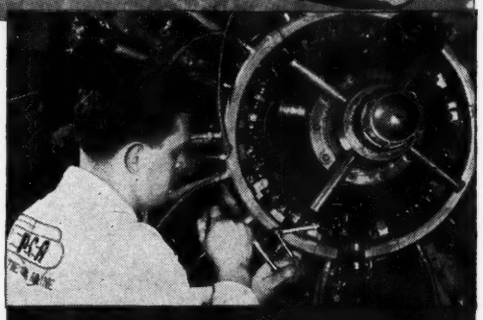
"Snap-on Tools CONTRIBUTE TO HIGH UTILIZATION AND RELIABILITY"

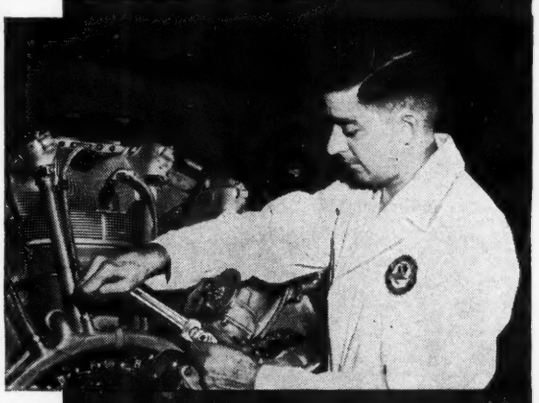
A pioneer in America's air transport industry, the history of PCA (The Capital Airline) is one of sound operation and progressive leadership in serving a large and expanding network of key cities. Soon an impressive new fleet of Capitaliners will fly the PCA skyways . . . huge four-engined Douglas sky giants seating 56 passengers, and presenting a new conception of swift, luxurious air travel.

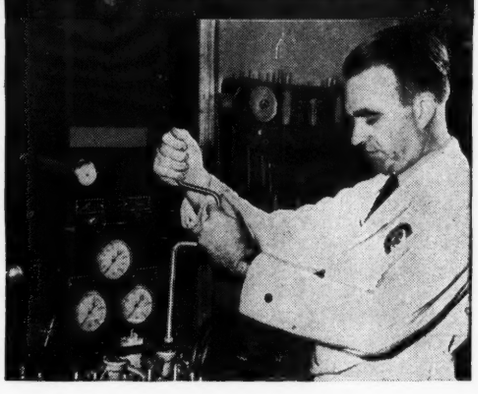
In the maintenance of these great Capitaliners — as in PCA's maintenance operations for many years — Snap-on tools will play an important part. "Snap-on tools . . . contribute to high utilization and reliability", says B. J. Vierling, Chief Engineer.

The stand-out choice in every field of aviation, Snap-on tools are used in the maintenance operations of every major airline. Snap-on's nation-wide tool service is available through 38 factory branch warehouses in important aviation centers. Write for Snap-on catalog and address of nearest branch.

SNAP-ON TOOLS CORPORATION, 8020-A 28th Ave., Kenosha, Wis.

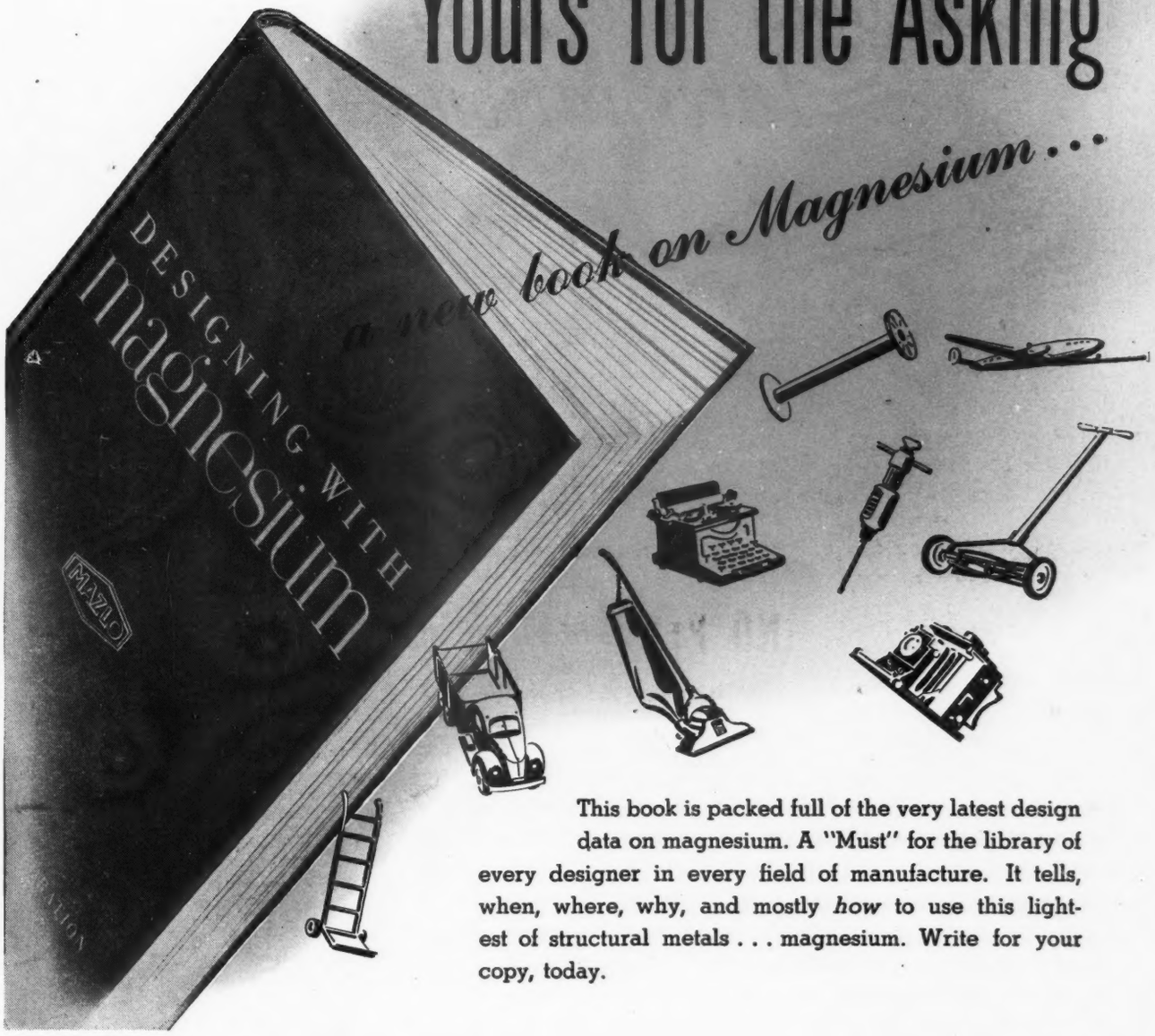






Yours for the Asking

a new book on Magnesium . . .



This book is packed full of the very latest design data on magnesium. A "Must" for the library of every designer in every field of manufacture. It tells, when, where, why, and mostly *how* to use this lightest of structural metals . . . magnesium. Write for your copy, today.

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

PLEASE SEND ME

Designing with Magnesium ➡

Aluminum Company of America
(Sales Agent for Mazlo Magnesium Products)
1713 Gulf Building, Pittsburgh 19, Pennsylvania

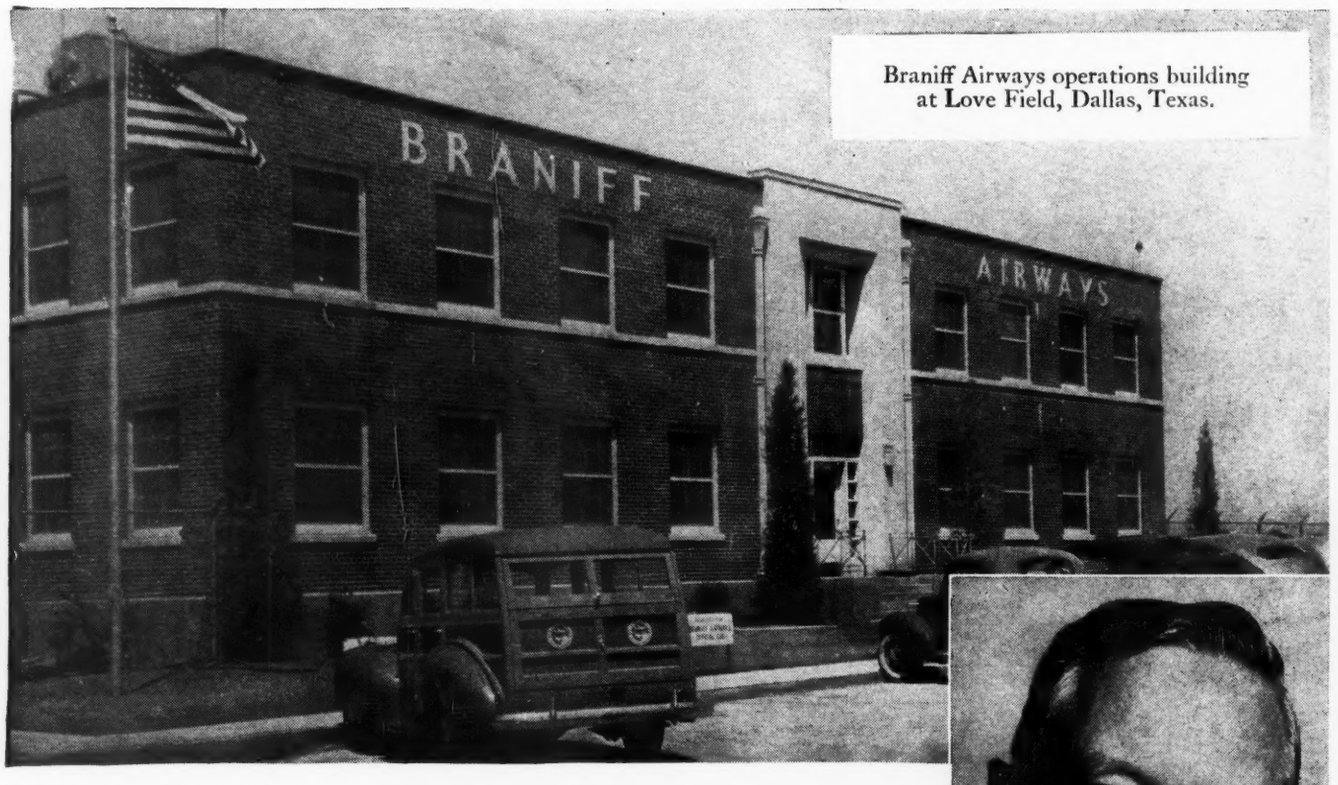
Name_____ Title_____

Company_____

Address_____

City_____ State_____

BRANIFF AIRWAYS—
Oklahoma Acorn to International Oak



Braniff Airways operations building at Love Field, Dallas, Texas.

People who talk about the pioneer days being over and the lack of new fields for conquest don't know Tom Braniff and the Braniff legend.

For one of the characteristics of Braniff Airways has been that it has always kept its eyes on the ever expanding horizons of aviation.

Starting with one plane, three employees, and a 116 mile route from Oklahoma City to Tulsa, Braniff has become one of the leading air carriers of the country—3,749 miles of domestic routes, flying 28,000 miles daily, and with over 1,500 employees.

And now, the erstwhile little Oklahoma airline points toward becoming an important factor in International aviation!

People like Braniff *must* be on their toes. That's why we think it is significant that their planes use Phillips Aviation Gasoline.

We firmly believe that the best indication of the quality of a product is the kind of people who use it. Nuff said! Aviation Department, Phillips Petroleum Company, Bartlesville, Oklahoma.

T. E. Braniff, President of Braniff Airways, and one of the great pioneers of domestic airline operation.

Phillips
AVIATION GASOLINE

...ON ALL LEADING AIRLINES
THE WORLD'S GREATEST LUXURY AIRLINER

Before long you will have an unforgettable travel experience...your first ride in the huge new Douglas DC-6, the world's greatest achievement in transport aviation. Cruising at more than 300 miles per hour along the routes of leading airlines, it will carry you to your destination in comfort and assurance beyond anything ever before imagined.

GREATEST NAME IN AVIATION **DOUGLAS DC-6**

Sister Ship of the Famous C-54 Combat Air Transport

HYCON
POWER UNIT

3000 P. S. I. CONTINUOUS DUTY

40″ long, 17″ wide, 25″ high

2.25 GPM 3000 P.S.I. Pump on Motor
10½″ OD Accumulator Mounted and Piped
on 20 Gal. Reservoir. Micronic Filter

A PACKAGED UNIT FOR ANY HYDRAULIC CIRCUIT

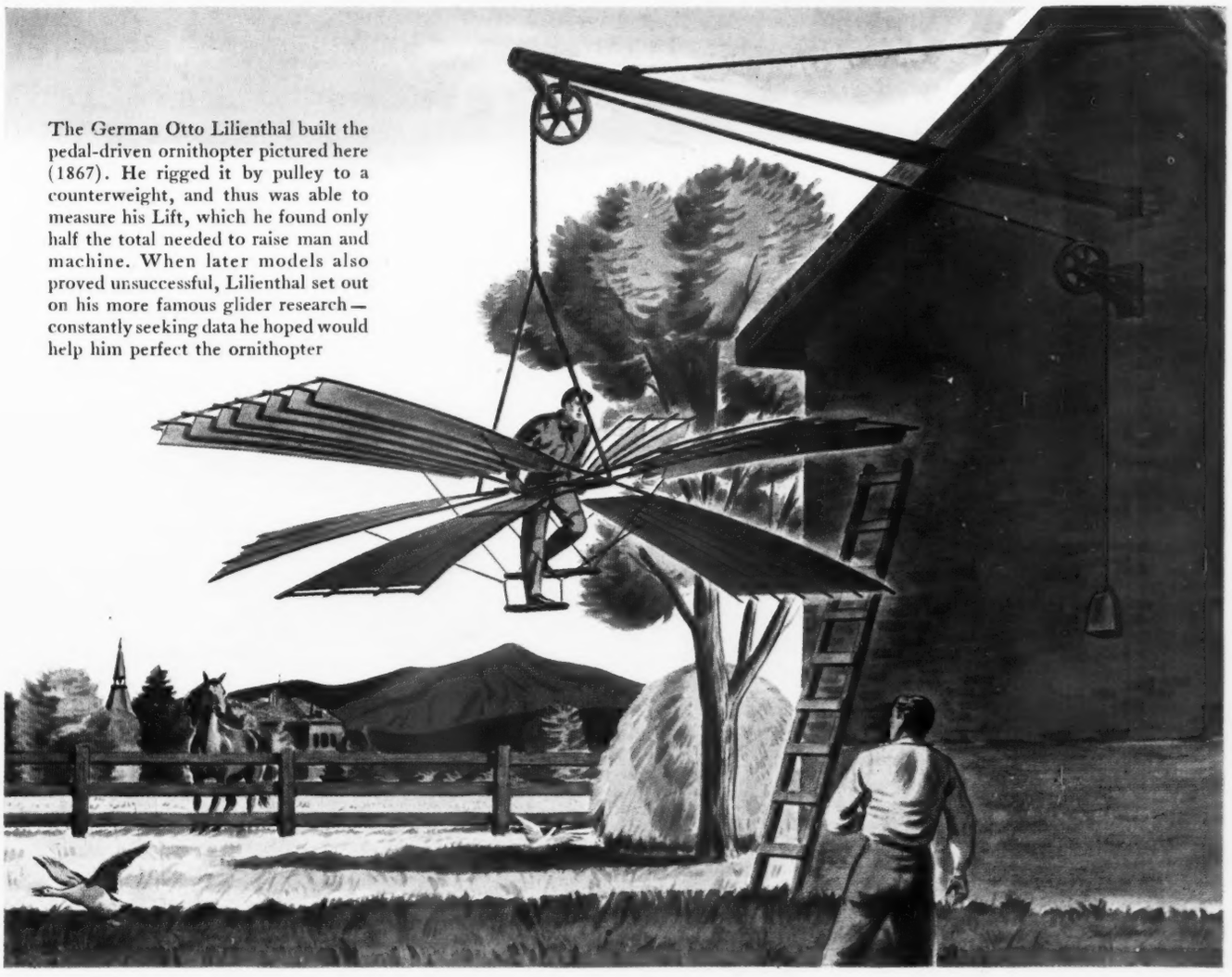
RECORD PRESSES • LABORATORY PRESSES • ARBOR PRESSES • JACKS • MACHINE TOOLS • APPLICATIONS REQUIRING LONG DWELL UNDER PRESSURE

EXPERIENCED HYDRAULIC ENGINEERS WILL CALL UPON REQUEST

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 Lexington Avenue, New York, 17, N. Y. • Factories Watertown, N. Y.



The German Otto Lilienthal built the pedal-driven ornithopter pictured here (1867). He rigged it by pulley to a counterweight, and thus was able to measure his Lift, which he found only half the total needed to raise man and machine. When later models also proved unsuccessful, Lilienthal set out on his more famous glider research — constantly seeking data he hoped would help him perfect the ornithopter

In a barnyard, LILIENTHAL LEARNED HOW TO MEASURE THE *LIFT* OF WINGS

In aviation there is a battle not yet finished. It is man's struggle to increase the useful force of air around a wing, and to reduce the friction of air against a plane's surfaces. It is the continuing battle of *Lift* versus *Drag.*

During the past twenty years, the victories in this battle have been many, a notable number scored by Northrop. Toward Drag-reduction, for example, Northrop pioneered the monocoque fuselage in 1927. Multicellular, internally-braced wings and wing fillets for monoplanes came from Northrop in 1929. And, in 1932, Northrop introduced the first split flaps to increase Lift in take-offs and landings.

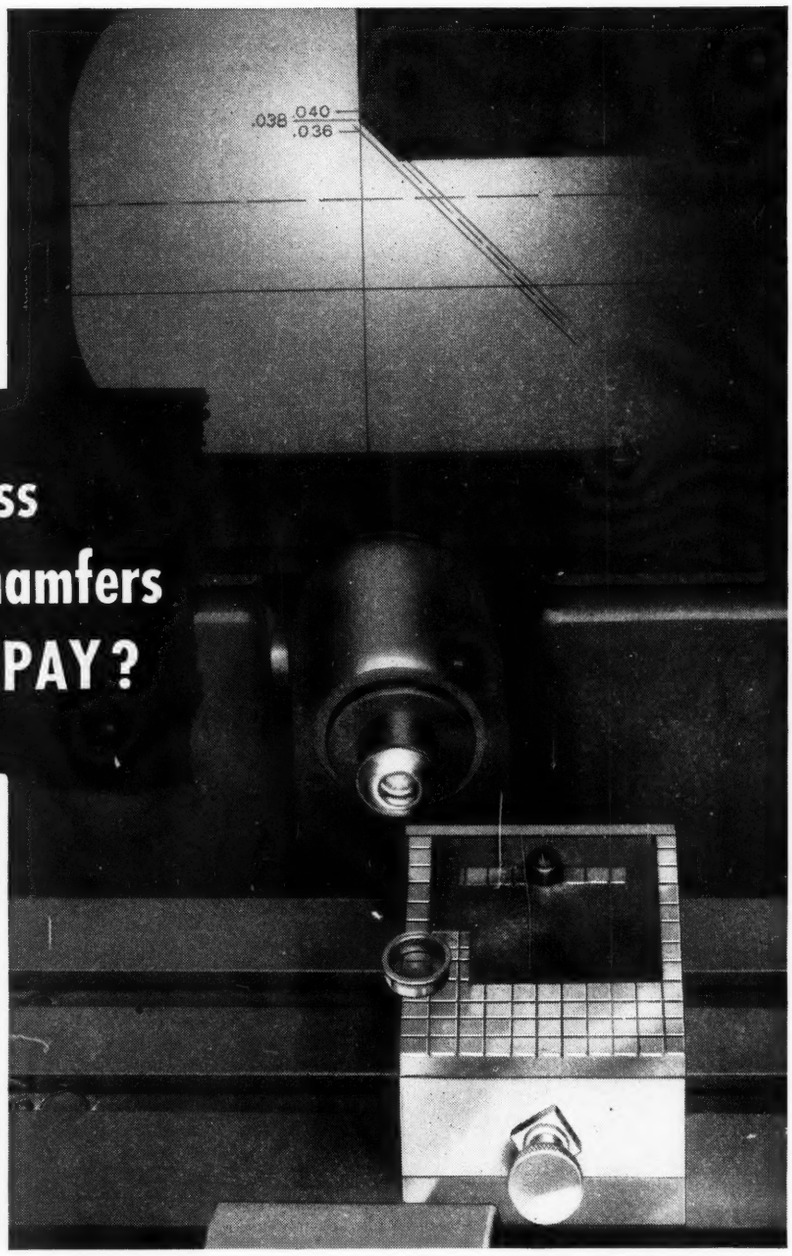
The years 1935 to 1941 brought other Northrop advancements: The first double-split dive flaps . . . heliarc welding of magnesium for lighter, smoother construction . . . the first retractable ailerons. And the first successful all-wing airplane, the Northrop *Flying Wing,* which housed everything inside the wing.

What next in the battle of Lift versus Drag? Many of the answers will come from Northrop, from plans already set to create both more efficient propulsion and planes of still more advanced design. Northrop Aircraft, Inc., Northrop Field, Hawthorne, Calif.

ARMY (E) NAVY

NORTHROP

Creators and Builders of the ***Black Widow*** *P-61 Night Fighter and the* ***Flying Wing***



If it pays to fuss about details like chamfers ... WHO DOES IT PAY?

After all, what's a chamfer on a ball bearing? Just the bevel on the edges of the outer ring that permits the staking or spinning operation to hold the bearing securely in the housing . . . almost the smallest detail. Is it worth enough to plane builders and maintenance people to be worth checking the chamfers on every single aircraft bearing with a comparator, as Fafnir does?

It wouldn't pay Fafnir to do such expensive inspection unless somebody was willing to pay for the certainty that every chamfer on every bearing was exactly right. Naturally, they'd be the people who couldn't afford to take chances on even one bearing failure . . . the men who design and make most of the military, commercial and private planes in America . . . who buy more Fafnirs than ball bearings of all other makes put together.

Of course, chamfers accurate to the thousandths of an inch are just as important to maintenance people as they are to plane makers. The precise contours of the chamfers on Fafnir Bearings make installation and removal of bearings many times quicker and easier. There are no compensations to be made for irregularities . . . and no uncertainties about the finished job.

Granted, it's easy enough to see how large plane makers and maintenance shops could go in for extreme care . . . and make it pay. Their customers expect such perfection. Maybe your business *is* as different. And maybe *your* customers are different. All that Fafnir is suggesting is that it might be something worth talking over with your shop men. The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR

BALL BEARINGS

For Aircraft

INCENTIVES FURNISH THE DRIVE

THE COMING YEAR, 1946, and the years to follow can bring unprecedented prosperity to the people of the United States if the incentives to secure it are provided.

We have the advantage of starting with an economy which has demonstrated a capacity for expansion unequalled in any other country in the world. Our economy has demonstrated, also, one grave weakness—a recurring interruption of the upward trend of production and living standards by wasteful and paralyzing periods of recession. Recovery from each depression always has carried us to new heights of economic welfare, but the toll of the years of blight has been harmful to everyone.

The job ahead of us is a dual one. We must maintain the vitality of an economy which, over the years, has yielded an enormous increase in the American standard of living, and we also must improve its stability.

The Dynamics of American Production

In the last prewar year, 1940, the population of the United States was 3⅓ times as large as it was in 1870. But the national production, measured in dollars of constant purchasing power, was 10 times as large at the end of the period, and industrial output had increased 20-fold.

In the meantime, the average number of hours of factory workers had been reduced from about 63 per week in 1870 to less than 40 in 1940, while average hourly earnings had more than trebled in dollars of constant purchasing power. Thus "real" weekly or annual wages in manufacturing had doubled over the 70-year period, even though the work-week was cut by 35 per cent. This was made possible chiefly by a tremendous increase in the quantity and quality of the mechanical facilities which were provided in American manufacturing industry. Manufacturing capital investment per worker was multiplied by 6 times over the period in question. But the return per dollar invested, while it has fluctuated widely between good years and bad, showed no general upward trend over that portion of the period for which measurement is practicable.

Incentives in American Manufacturing

There has been, historically, a remarkably consistent pattern in the division of the realized income from the expanding manufacturing output of America. Reliable statistics are not available for as far back as 1870, but from 1899 through 1939 the average share of wages and salaries has been 82½ per cent against 17½ per cent as the share to investors (including dividends, interest, rents, royalties, and non-corporate profits). There have been, from year to year, relatively minor divergences from this pattern of distribution, but there is no discernible trend during the period away from the averages cited.

It is suggested that the persistence of the average 17½ per cent share of realized income from manufacturing that was maintained for the 40 years preceding World War II may represent the proportion that is needed to produce the dividends, interest, rents, royalties, and non-corporate return that will provide for the continuing investment upon which an expanding productivity such as we have had in the past depends. At any rate, it would seem reckless to depart too radically from such an established pattern at a time when unprecedentedly large private capital investment is counted on to make up for the drastic curtailment of such investment during the war years, and to carry us to the new high levels of civilian production set as our postwar goals.

The Distribution of Manufacturing Income in War

At the beginning of the war, the Government adopted controls and a tax program designed to prevent wartime activity from resulting in un-

duly swollen private returns. Due primarily to huge volumes, the profits *before* taxes of manufacturing industry were very high, but throughout the war its profits *after* taxes averaged returns no larger than they had been in good prewar years. Relative to volume, they were considerably lower than in prosperous years in the past. Again, there can be no complaint at results that generally were in accord with a national wartime policy.

But it is fair to note that the wages of manufacturing labor were allowed to increase substantially during the war. Between January 1, 1941 and April, 1945, average weekly earnings per worker increased by 77 per cent. This was, in considerable part, a result of increased working hours and a shift from low- to high-paid industries, but straight-time hourly earnings on the same jobs increased about 40 per cent against a cost-of-living rise of about 30 per cent.

The net result was to alter drastically the 40-year relationship of the 17½-82½ per cent division of Realized Income from Manufacturing. The share of wages and salaries increased to over 90 per cent, and the investment share shrunk to less than 10 per cent.

Its Postwar Distribution

This wartime shift in the proportion of distributive shares has an important bearing upon current wage controveries. With union demands for wage increases ranging up to 30 per cent, and the economists of the Office of War Mobilization and Reconversion asserting that an average increase of 24 per cent is feasible without raising prices, it is pertinent to inquire how such increases would affect the prewar ratios that governed realized income distribution in manufacturing.

Forecasting is always hazardous, but if we assume (1) that in 1946 we shall reach the $160 billion level of national output which the Government proponents of general wage increases expect, and (2) that there will be little increase in productivity because of the continuing process of reconversion, and (3) that the Government will succeed in carrying its announced purpose to maintain present price ceilings, it appears that a 24 per cent general wage increase would reduce the share going to capital from 17½ per cent to 11 per cent even allowing for its increased return resulting from the repeal of the excess profits tax. The prewar ratios would be about maintained if wages remained at present levels.

Conclusion

Since the maintenance of these prewar ratios was accompanied by an unparalleled rise in the "real wage" of American workers, there is a powerful prima facie case for not tinkering with them. It should be noted, however, that some economists think that the size of the investment share of manufacturing income tends to provide more capital than can be absorbed by a mature economy, and thus contributes to those breaks in the expansion of the economy which, as stated at the outset, have been its principal blight.

Regardless of what may ultimately prove to be the validity of this view, no one can responsibly contend that at this early but crucial stage in the reconversion process is the time to test it. Now, no one knows whether, or what dimension of, additional wage increases can be supported without forcing up prices or reducing profits to a point that will discourage vitally needed private capital investment.

We want high and increasing wages in American manufacturing. We need them to provide an active incentive to workers to support expanding productivity, as well as to continue the trend of rising living standards in America. Equally, we need a continuing profit incentive of sufficient attractiveness to call forth the new investment upon which expanding productivity depends.

We can never attain our dual objective if we push one of these aims so far and so fast that it defeats the other.

President, McGraw-Hill Publishing Co., Inc.

EDITORIAL

TAKE ELDON, FOR INSTANCE—

As we enter our first peacetime year after a long and devastating war, individual enterprise is straining at the bonds of government control and is full of eagerness to get going. Americans are anxious to put their wartime savings to work in business large and small. In fact, this accumulation of funds must be placed in circulation if we hope to support our national economy at a level sufficiently high to enable us to pay our debts.

Suppose you are a business man looking for a logical location for your plant, or store, or office. First, you study all the basic market yardsticks and listen intently to the presentations of the local chamber of commerce. But you should go one step further and try to fathom a less tangible factor—the progressive spirit of the community you are considering as your business home.

Perhaps this may seem a little vague to the practical hardheaded business man. But this spirit may easily represent the difference between slow and rapid community growth—and, accordingly, the growth of every business man and professional man who lives or works there. One of the ways you can gage the progressive spirit of a city is by studying its airplane plans.

This approach is not mere academic theory. That it really works has been demonstrated by actual experience. Take, for example, the commercial benefits that came to Eldon, Mo., as an indirect result of its sound, well-publicized, airpark project. Eldon is small in size but large in progressive spirit. And as a result, the community is growing. Before its airpark project was publicized, it had at least twelve vacant store buildings. Now space is at a premium. Here are a few instances of expansion or new businesses which have come to that community—

One existing shoe manufacturer expanded his facilities. Another raised $35,000 for a new plant to be occupied as soon as it is built. A cheese factory expanded to the extent of $75,000. One of the finest gift shops in the state was opened in a building which had long been vacant. A grocery company went into a remodeled and better building, a garage moved in from out of town. A locker system, furniture store, greenhouse, turkey hatchery, jewelry store, theater, hotel, and two concrete-block factories were among many other businesses which either expanded or set up activities in Eldon. Even a veterinary came to town—for the first time in 20 yr. And a new bus line obtained a franchise to operate from the town.

It would be ridiculous to say that all these businesses came to Eldon to use its airpark. But several of the business men have told the city fathers that the airport project was the determining factor in their decision to expand or locate in the town. As time goes on these men will undoubtedly use the airpark and the services it offers for business or pleasure, or both.

Other communities can advantageously follow Eldon's example. A few already have, and of their experience has come a new conception of the airpark and its value to the community.

Often, an airport can be made into a self-liquidating project. By judicious management it can be made to pay all or a great part of the investment it requires. But communities must think beyond the idea of an airport being a business within itself. They must consider its value in promoting the community as a whole and stimulating new business and new employment within it.

This story of Eldon proves that the efficient planning, sound management, and adequate promotion of an airport project can and will bring growth and prosperity to any wide-awake community.

Leslie E. Neville

EDITOR

PRIVATE ENTERPRISE FIGHTS TO KEEP FLYING

AUSTRALIA HAS BEEN LATEST FIELD OF FRAY

By H. BOWDEN FLETCHER, D.F.C., *Australian Correspondent of "Aviation"*

DESPITE THE OPPOSITION mustered by the private-enterprise airlines, significant victories have been won by the airline-nationalization forces in both England and in Canada. And here in Australia, private hopes have likewise now been dimmed. In consequence, apprehension continues to grow among private air interests everywhere.

Developments in the conflicts between government and private interests in lands across the seas were, quite understandably, closely observed by our airway operators—for the same opposition forces had been identified in our own land. And they quickly grappled.

What has happened thus far is certainly not encouraging to our private operators. Already, our airline nationalization bill has become law. However, at this writing no official commission has been appointed to operate the new company which would be formed. Moreover, the initial case of enforcement is expected to bring quick legal action by the existing private lines—which would mean a delay of at least twelve months before the statute's legality could be determined.

The stand which has been taken by the operators specifically reflects the varied factors. Since these will be found of interest by American readers, this writer approached executives of the inter-state companies and was in turn referred to the airline operators' secretariat headquartered in Melbourne.

C. C. Mooney, chief executive officer of the secretariat, carefully explained the group's viewpoints. He also told of the various measures undertaken—the vigorous advertising campaign against the government proposal, the group's pledge to fight the constitutional aspects of the nationalization bill, and the decision to carry the case through the Australian courts and, if necessary, take it to the Privy Council in England, final arbiter of constitutional law for the British Commonwealth of Nations.

The premises were revealed via a series of key questions which the writer had drafted in order to gage the thesis in detail, and Mr. Mooney's very candid answers are given in the text which follows:

1. **Question:** Has it been the Commonwealth's intention to nationalize all airlines?

Answer: No. The intention has only been to nationalize "inter-state" airlines. The legislative power relied upon is that contained in Section 51 (1) of the Constitution, which empowers the Commonwealth to legislate with respect to "trade and commerce with other countries and *among the States*".

Such nationalization of airlines, therefore, becomes a test as to the power of nationalization generally. For if under this power airlines may be nationalized, so may be any industry that operates inter-state.

If the power in relation to "inter-state airlines" is established, nationalization of overseas airlines becomes also practicable under the power with respect to "trade and commerce with other countries" as may also power to nationalize any industry having export or import characteristics.

No power exists to nationalize purely intra-state airlines or any purely intra-state industry.

2. **Question:** Was nationalization proposed because of any inefficiency in "inter-state airline" operations?

Answer: Upon the contrary, the operations of the Australian inter-state airlines are as efficient as any in the world. For example, the major inter-state operator is Australian National Airways. This company operates the largest internal airline network in the world, and among world domestic airlines it is the sixth largest passenger carrier and one of the largest mail and freight carriers.

A comparison (see accompanying table) of its figures with the figures of leading American airlines—America being the country with greatest domestic airline development—is particularly interesting. It will be seen that while the operations of the Australian company are greater than those of the average American company, the charges for services—i.e., passengers, mail, and freight—are lower. Yet these lower charges have been achieved in spite of the fact that petrol and oil costs are three times higher than in America. This is a clear demonstration of the efficiency of the Australian operator. The same types of planes are flown, the same standard of service is given, the only distinction being the lower rate of charge.

Key to the efficiency is probably the organization, which enables a daily average flight per plane of 1,555 mi. as against the American average of 1,463.

3. **Question:** Was nationalization proposed because of a weighty subsidization of the inter-state airlines, making their operations a charge upon the tax payer?

Answer: No. Not one of the major inter-state airlines is subsidized. Not

COMPARATIVE FIGURES—AUSTRALIAN NATIONAL AIRWAYS AND AVERAGE OF AMERICAN LINES

	ANA	Average of 21 American Airlines
Daily average miles flown per plane	1,555	1,463
Passengers carried, annual	325,000	164,478
Total passenger-miles, annual	146,682,000	78,218,888
Average passenger fare per mile	3.92d. (5.1¢)	4.127d. (5.4¢)
Route miles of domestic airmail service	9,387	2,157
Airmail pound-miles	3,761,195,767	2,699,688,128
Payment per pound originated for mails	4s. 4d (69.9¢)	7s. 8d. ($1.236)
Airmail payment per plane-mile	17.95d. (23.3¢)	19.81d. (25.7¢)
Payment per pound of freight carried	8.66d. (11.2¢)	10.43d. (13.5¢)
Cost of petrol and oil per mile (DC-3)	21.9d. (28.5¢)	6.86d. (8.9¢)

Note: Conversions into American money are approximations based on Australian pound equals $3.235.

Both England and Canada have seen the airline "nationalizers" win strong initial holds—and now a nationalization bill has become law in Australia. Yet the "Down Under" airlines still resist, and to evaluate their stand, Aviation's Australian correspondent put eleven searching questions to the operators' secretariat. The pointed answers—given here in full—will go far toward clarifying the picture for watchful American interests.

one penny of the taxpayer's money is spent on civil aviation. Upon the contrary, the airlines return a profit to the Government.

4. **Question:** You claim the airlines return a profit to the Government. How?

Answer: The Government levies a surcharge of 3d. (3.9c*) per half ounce —in addition to the 2.5d. (3.2c) per ounce ordinary postage—in respect of each airmail letter posted. The 2.5d. ordinary postage covers all the ordinary postal service such as collecting from mail boxes, sorting, and delivering at destination, and also included is the ordinary post office profit on the letter. The one variation from normal in the transit of the letter is that instead of being carried by rail, car, or ship, it is carried from airport to airport by plane. The airline companies contract with the Government to perform this carriage. They charge considerably less than the 3d. surcharge which provides for the cost of air transport. In fact, 42 airmail letters make the pound weight. For this pound, the Government receives 10s.6d. ($1.70) in airmail surcharge. For the carriage, the companies are paid 4s.3d. (68.5c), the Government retaining 6s.3d. ($1.01) as profit. In 1944, the mail surcharge totaled £1,680,546 ($5,436,566). Payments to airline contractors totaled £884,023 ($2,859,814), leaving a surplus of £796,523 ($2,576,752). From this £796,523 the Government paid all expenses of civil aviation administration and was left with a final surplus of £428,722 ($1,386,915).

5. **Question:** Since the Government has, as it says, spent millions in provision of civil aviation facilities, is it not right that the Government should run the airlines rather than allow a few private operators to have the benefit of this expenditure?

Answer: Should the Government own all merchant and passenger vessels because it provides all the port facilities upon which shipping relies? Should it own every car and cart and wagon because it provides the roads? Should it own every house because it provides the roads upon which the houses front and depend for exit and entry? Surely not. Certainly the place of the Government is to provide facilities, at an appropriate charge, for the use of trade and commerce generally. The facilities are for a general use which no one trader could economically provide and to which no one trader should have exclusive title.

In fact, the total capital expenditure by the Government on civil aviation facilities is £3,987,237 ($12,898,711). Of this amount, £2,792,383 ($9,033,359) has been spent in the years 1940-1944 and the expenditure represents defense work, little of which will be of any use at all for civil aviation purposes. However, civil aviation has been charged with the expenditure, and the revenue is buoyant enough to accept it.

For the year 1944—on the basis of the whole capital expenditure of £3,987,237—the aforesaid net surplus of £428,722, after paying all expenses, represents a return of 10.75%.

Allowing for interest at 4%, there would be a balance for a sinking fund of £269,233 ($870,968), so that the expenditure, unlike other Government ventures, represents a healthy investment that will soon be paid off.

That this is so is due entirely to the efficiency of the operators who operate at lowest rates, thus yielding a wide margin of the airmail-service charge to revenue.

6. **Question:** Should not the Government own the airlines because of their strategic importance and the necessity for their development for defense purposes?

Answer: No. Such a view is based on lack of appreciation of airline operation. Firstly, those who think this way may find a warning in the fact that the United States believes in pri-

(*Turn to page* 190)

*This conversion and those which follow are approximations based on Australian pound equals $3.235.

"From Wheels to Blade Roots"

It's TIMKEN BEARING EQUIPPED

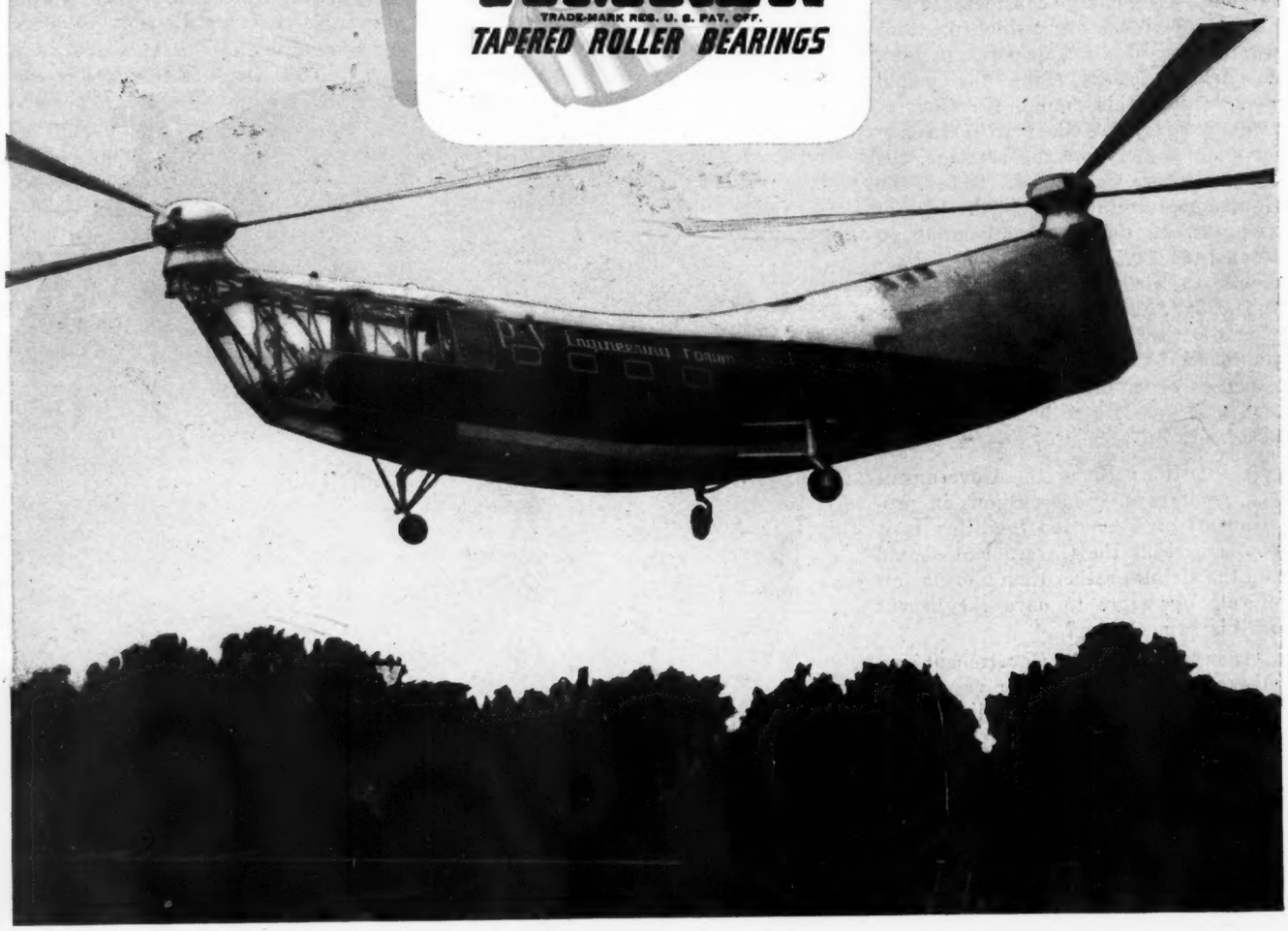
To give it maximum radial, thrust and combined load-carrying capacity—as well as lighter weight and greater compactness—manufacturers of the PV-3, world's largest helicopter, equipped it "from its wheels to its blade roots" with matchless Timken Tapered Roller Bearings.

For the many great mechanical advantages and universal acceptance of Timken Bearings can not be duplicated—and aircraft engineers everywhere are making good use of them.

But no matter what your particular requirements may be, there is a Timken Bearing to meet them. This "first and best" tapered roller bearing has all the qualities of endurance, performance and economical maintenance for which anyone can ask. Get these advantages by seeing to it that the bearings you buy are stamped with the trade-mark "TIMKEN".

Why not write - - our engineers will be glad to make specific recommendations. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



DESIGN ANALYSIS OF

GENERAL ELECTRIC TYPE I-16 JET ENGINE

By MAJ. RUDOLPH C. SCHULTE, *Project Officer, Turbojet and Gas Turbine Developments, Hq., AAF*

First factual study of this new-aeronautical-era power plant—America's basic engineering contribution to the development of turbojet jobs—revealing detailed features of major components, installation, operation, and performance . . . The 16th in Aviation's unmatched analytical series.

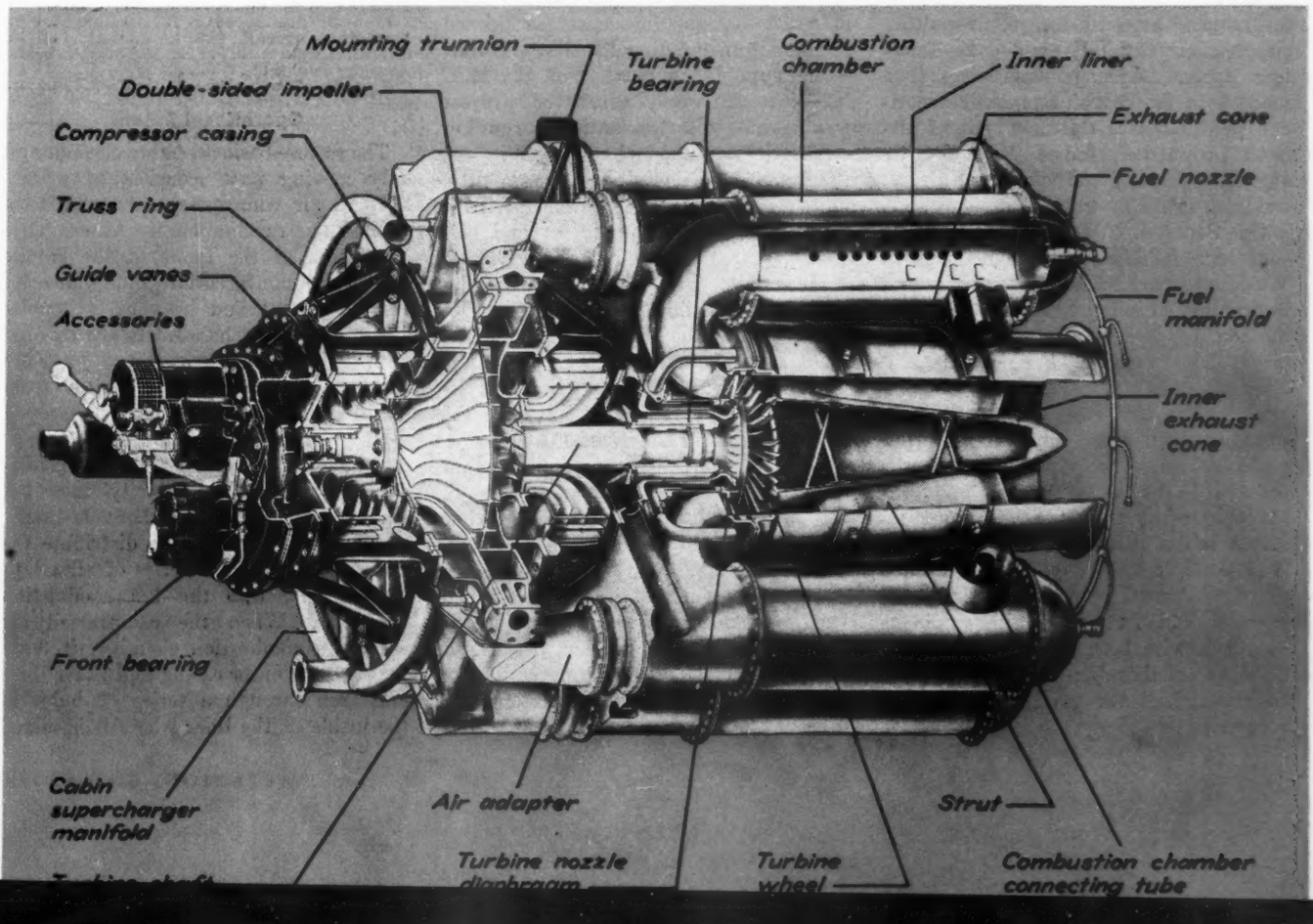
As ALLIED SUCCESSES progressed favorably in World War II, more and more information was made public on the advancement of jet propulsion research and development by both the AAF and BuAer. Yet the releases divulged very little about the most vital unit of the development—the jet propulsion engine.

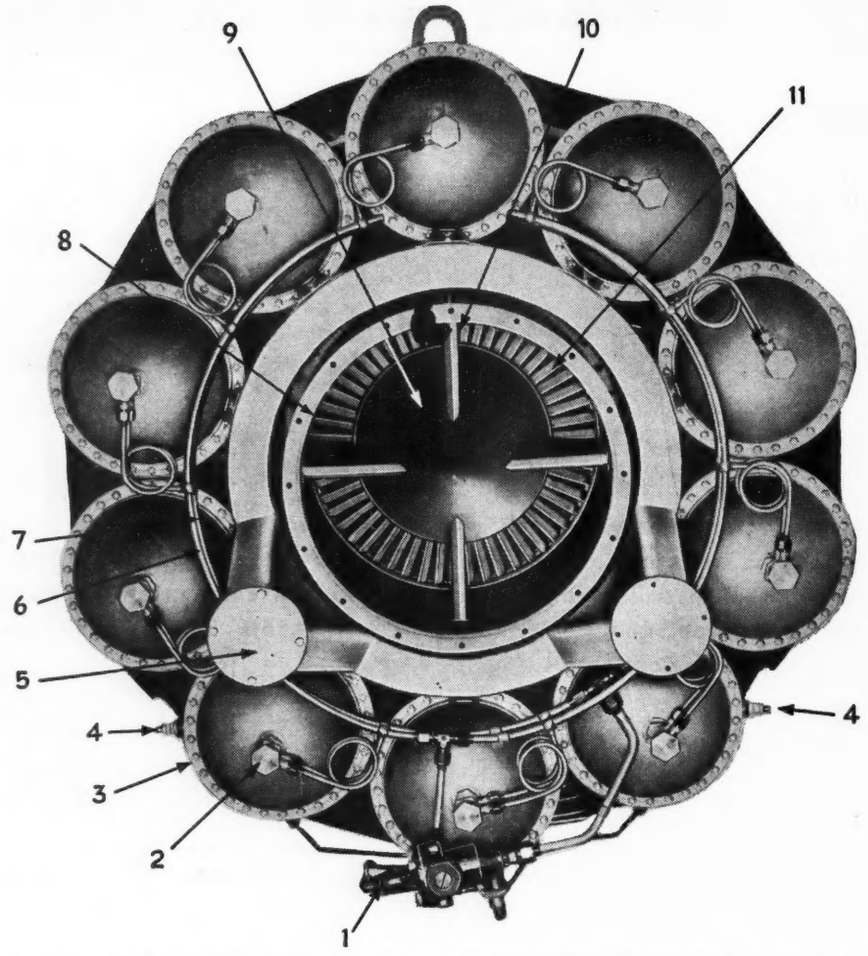
The General Electric Type I-16 jet engine and the Bell P-59A Airacomet were pioneer developments in a new and important era in American aviation. The first American jet propulsion engine—turbojet unit, as it is now known—was built by GE at West Lynn, Mass. Behind this prosaic statement of fact is an outstanding record of achievement by industry and the military services.

Basic conventional engines used in our combat aircraft had substantially reached the limits of power of which they were capable without major changes and redesign. Such major changes and redesign were, of course, not feasible in the short time available while the war was being fought. It became apparent that still more speed was essential and this could not easily be obtained with piston engines available. Jet propulsion appeared to be an obvious solution—particularly since theoretical studies indicated that certain forms of jet propulsion resulted in an increase of thrust as the value of speed was increased.

While visiting England early in '41, Gen. Arnold had an opportunity to examine, first hand, the results of British activities in the field of jet propulsion. Air Commodore Frank Whittle had designed a jet propulsion engine which had been built and successfully tested by the Thomson Houston Co., Ltd. During May, 1941, a jet-powered Gloster successfully completed a series of flights

Cutaway view of General Electric Type I-16 turbojet engine (military designation I-31).





Rear view of turbojet unit: (1) Duplex meter valve, (2) fuel nozzle, (3) combustion chamber dome, (4) sparkplug, (5) cooling air manifold, (6 and 7) rear and front fuel manifolds, (8) exhaust cone, (9) inner exhaust cone, (10) strut, and (11) turbine wheel.

totaling about ten hours. This accomplishment impressed Gen. Arnold so favorably that he considered it highly desirable to expedite the jet propulsion program already initiated for the American forces. Arrangements were then made with the British to permit American production of this new type of aircraft propulsion, and a WIX Whittle engine, which had undergone test flights, was also made available.

On Sept. 4, 1941, after an initial conference held in Gen. Arnold's office in Washington to discuss the feasibility and desirability of going into immediate production on the Whittle engine, it was decided to proceed at once. General Electric—because of its previous vast experience in the design and production of steam turbines, supercharger impellers, and turbo-superchargers—was selected to build the engine and was also requested to undertake improvements in its design and performance. And the following day, it was decided that Bell Aircraft Corp. would build the plane in which the jet engine would be installed, with both companies working in close collaboration and coordinating their activities for maximum speed of achievement.

First test experience with the Whittle engine was obtained by GE in Nov. '41, resulting in a sl (sea level) static thrust of 1,200 lb., and data obtained proved invaluable in building the first GE unit —the Type I-A supercharger. In Mar. '42—just 28 weeks after the project was begun—this first unit was running on the test stand, and although it was the same in principle as the Whittle unit, many design changes had been incorporated to increase thrust and efficiency.

Meanwhile, Bell personnel were designing and building a twin-engine jet fighter plane—the XP-59A—and on Oct. 1, 1942, this craft, powered by two GE Type I-A turbojet engines, made its first flight at a remote test base in the desert area near the West Coast.

This flight symbolized an important achievement in aviation progress in this country, for within the short time of one year and three weeks, the complex problems involved in the design and construction of the jet plane had been overcome.

Early in the GE program, because of the need for design changes in the Whittle engine, modifications in the area of the diffuser throat, turbine nozzle, and exhaust nozzle were found necessary to reach the full rated speed without pulsation, and were incorporated in the Type I-A. And when tested in May, '42, this design gave about 1,400 lb. static sl thrust at 16,500 rpm. with a tail pipe temperature of 1,200 deg. F. and sfc. (specific fuel consumption—lb. of fuel per lb. of thrust per hr.) of 1.3.

Success of the Type I-A engine in flight and static tests spurred AAF personnel and GE engineers and metallurgists to increased efforts. Great strides were made in the development of high-temperature alloys, controls, accessories, and methods of bearing cooling, in combustion research, and in redesign for production. Thrust output was increased and sfc. lowered.

By Apr., '43, an improved turbojet engine, the Type I-16, was completed and running on the test stand. This power unit—rated at 1,650 lb. static sl. thrust at 16,500 rpm. with a tailpipe temperature of 1,180 deg. F, and sfc. of 1.18—became the first satisfactory American model to be released for quantity production.

The I-16 (Army designation, J-31) is substantially a complete power package weighing only 825 lb. with all attached accessories, and having an estimated installed weight of 1,054 lb. Dimensions and other mechanical data are given in the following table:

Table I—Type I-16 Turbojet Data

Impeller	20.69	in.
Diffuser throat area	30.6	sq. in.
Turbine nozzle area	54	sq. in.
Turbine pitch dia.	14.3	in.
Turbine nozzle & blade height	2.76	in.
Exhaust pipe dia.	14.4	in.
Jet nozzle dia.	12.4	in.
Maximum overall dia.	41.5	in.
Overall length	70	in.
Average weight	825	lb.
C.G. (aft of trunnion)	8.5	in.

Operational Details

The rotor—basic assembly element and only moving part—consists of a centrifugal air compressor connected to a single-stage turbine wheel. Atmospheric air enters at the front of the engine through circumferential guide vanes located at front and back of a double-sided impeller. These inlets are covered with a screen to keep large particles of dirt or other foreign matter from entering the air intake. Air is scooped up by the impeller, compressed to approximately 3.75 atmospheres, and discharged at a high velocity into ten equally spaced diffuser channels in the compressor casing, which distribute the air evenly through a series of air adapters leading into the ten combustion chambers. When the compressed air reaches a combustion chamber, it flows between the outer casing and inner liner and then through a series of holes to the inside of the liner where it is mixed

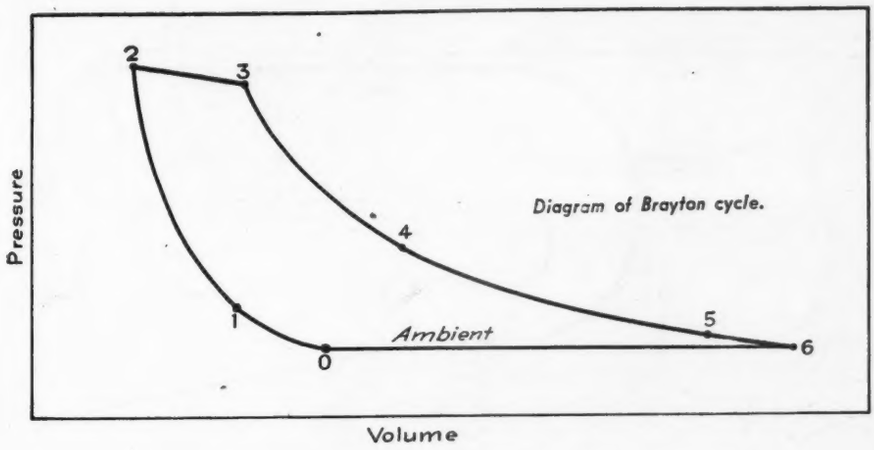


Diagram of Brayton cycle.

with fuel introduced by the fuel nozzle.

Burning of the fuel occurs all the way down the liner, and is complete before the gas enters the elbow leading to the turbine. During starting, the fuel is ignited by two sparkplugs—one each located on the outside of two combustion chambers. The resulting gas expands instantaneously and is directed through the curved blades of the turbine nozzle diaphragm against the blades of the turbine wheel, causing the latter to rotate and, in turn, drive the impeller via the shaft. A substantial amount of the energy in the gas is utilized by the turbine to rotate the compressor. The energy remaining in the gas is used to produce a high-velocity jet through the exhaust nozzle, and thrust is developed through reaction to this discharge.

The unit operates on the Brayton cycle, shown in an accompanying P-V diagram. The compression curve is designated by 0-1-2, and heat added at "constant pressure" is indicated by 2-3. Pressure loss in combustion chambers is also indicated as droop between 2 and 3, and curve 3-4-5-6 is the expansion line to ambient pressure. Conditions represented are as follows: Point 0 represents the condition of ambient air at rest; point 1, condition of this air at the inlet to the impeller after it has entered the ram inlet and has been diffused, with some efficiency, to reduce its velocity substantially to zero relative to the plane; point 2, air at the discharge of the compressor; point 3, gas at the inlet to the turbine; point 4, gas after expansion through the turbine; and point 5, gas at the nozzle throat. Points 5 and 6 tend to combine at 6 as velocities at the final jet nozzle reduce from supersonic to sonic, and they are one and the same point at all subsonic exit velocity conditions.

Major Components

Single-stage turbine. A nozzle diaphragm, turbine wheel, and a shaft make up the single-stage impulse turbine. The diaphragm—constructed of high-grade heat-resisting steel—has a series of curved blades designed to direct the gas against the buckets of the wheel. The low-alloy steel shaft is flash-welded to the Timken steel wheel and the assembly is heat-treated to relieve strains. Securely dovetailed into the outer rim of the wheel is a continuous circle of curved blades—buckets—forged from a nickel molybdenum alloy called Hastelloy B.

Centrifugal air compressor. A double-sided multiple-vaned wheel (impeller) enclosed in a casing, together with a diffuser, comprise the centrifugal air compressor. The impeller is a heat-treated aluminum forging capable of withstanding the high speed at which it must revolve. The curves of its vanes are designed to admit the high-velocity fluid without shock and to decrease the fluid volume by compression with greatest efficiency. Magnesium-alloy compressor casing consists of front and rear halves. The curved, smoothly machined undersurface of the front casing fits over the forward side of the impeller, and the rear compressor casing is cast with ten identical channels radiating outwardly. These channels constitute the diffuser, and through them the air is efficiently distributed into the elbows attached to the combustion chambers.

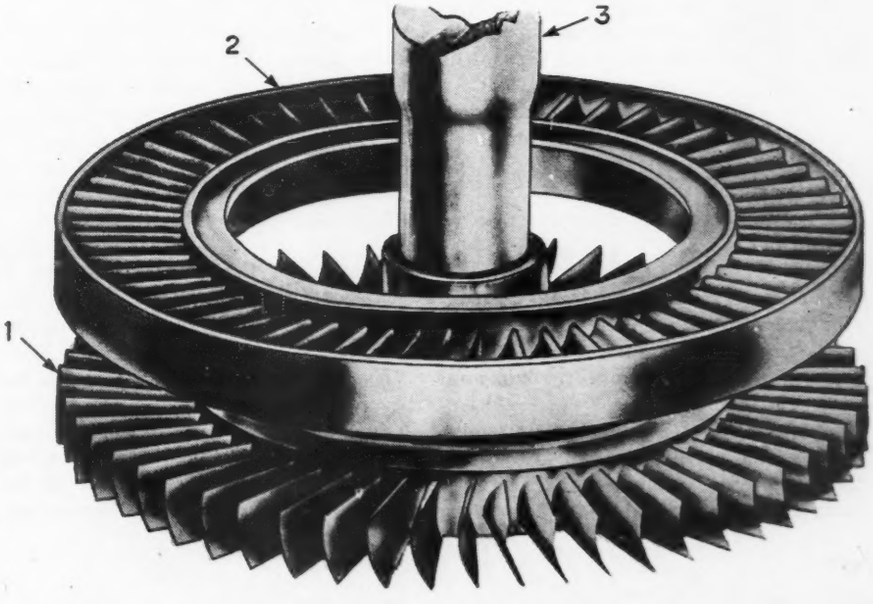
Rotor assembly. This component—turbine wheel and impeller at opposite ends of a composite shaft mounted on antifriction bearings—is a finely balanced precision assembly constituting the heart of the engine. The wheel shaft is machined with a ball-bearing journal, shoulder for an oil slinger, and a series of splines. After the slinger and bearing are slid down the shaft, a rear shaft—correspondingly splined—is fitted over the entire wheel shaft with a shrink fit. This composite shaft is then secured with a spring collar, shims, and a shaft locknut. The impeller is assembled to the end of the rear shaft with eight studs on one side inserted into drilled holes on the flange of the rear shaft, and eight studs on the other side of the impeller inserted into drilled holes in the flange of the front shaft. Assembled to the front end of the front shaft are an oil slinger and a ball bearing which are secured in place with a lock washer and nut.

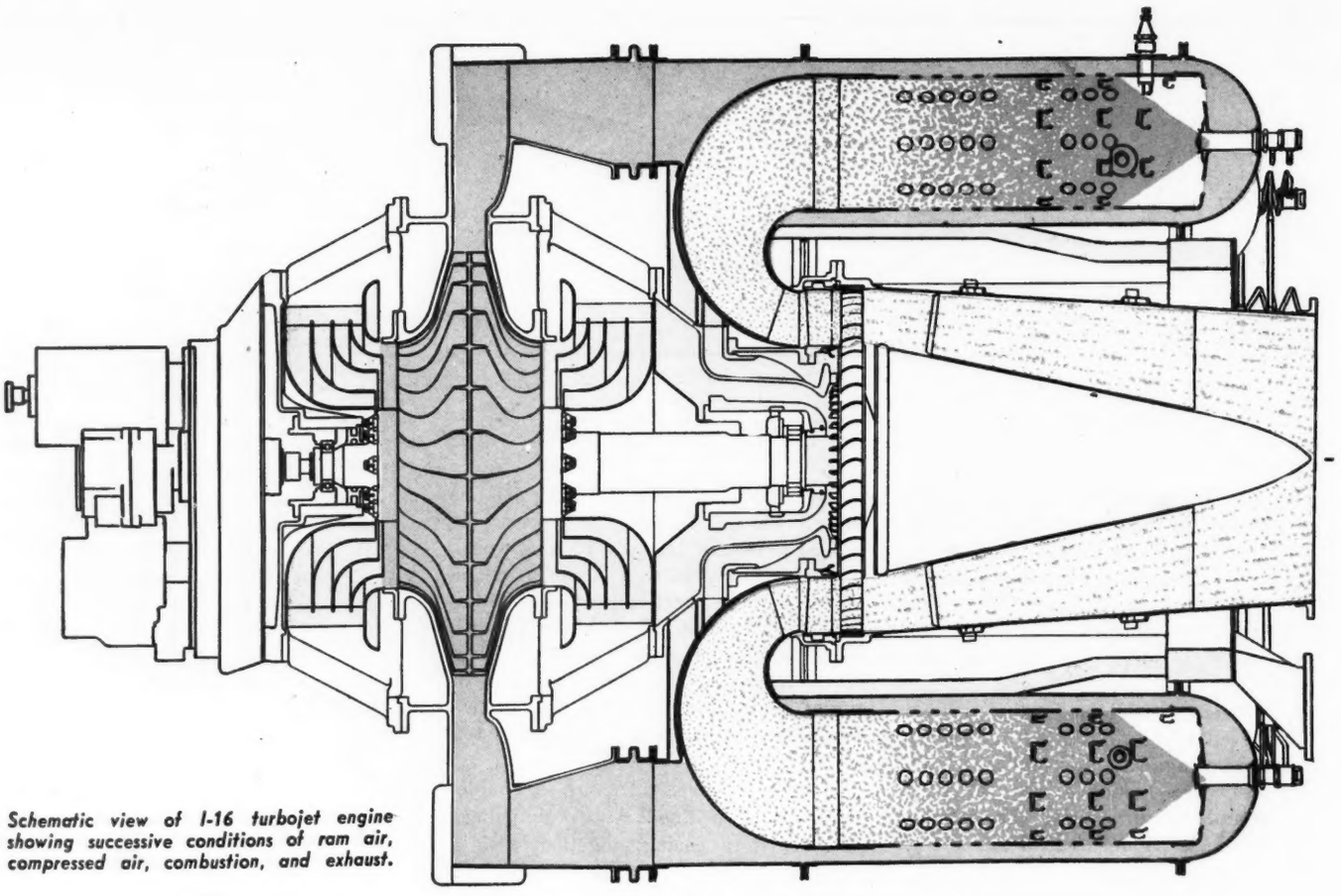
After the rotor has been assembled, it is given a run-out check at four places to insure proper alignment. After the rotor is in true alignment, it is dynamically balanced.

Combustion chambers. Each of the ten counterflow combustion chambers consists of an outer casing of stabilized 18-8 stainless steel and an inner removable liner of Inconel. Outer chambers are linked by short connecting pipes into which liner interconnectors of the same metal are inserted to link the liners. Each combustion chamber is sealed at the end by a domed cover containing a burner nozzle for introduction of fuel. A curved elbow leads from each combustion chamber to the turbine nozzle diaphragm.

Exhaust cone. This installation is a tapered cylinder-shaped outlet for the exhaust gas, and within it is a closed

Seen here are (1) turbine wheel, (2) nozzle diaphragm, and (3) shaft.





Schematic view of I-16 turbojet engine showing successive conditions of ram air, compressed air, combustion, and exhaust.

cone around which the gas is ejected in a gradually expanding jet form. All of the turbulence of the expanding gas is converted into direct thrust as it is discharged. Bolted to the unit at the rear of the turbine wheel, the exhaust cone extends out through the space in the center of the combustion chambers. The inner cone is supported within the outer cone by four radial rods covered with thin, streamlined stainless steel vanes. Material of the exhaust cone is stainless steel sheet flanged with steel forgings at both ends, and to keep as much of the heat energy as possible within the cone, it is covered with four layers of aluminum foil, each separated by a layer of bronze screening.

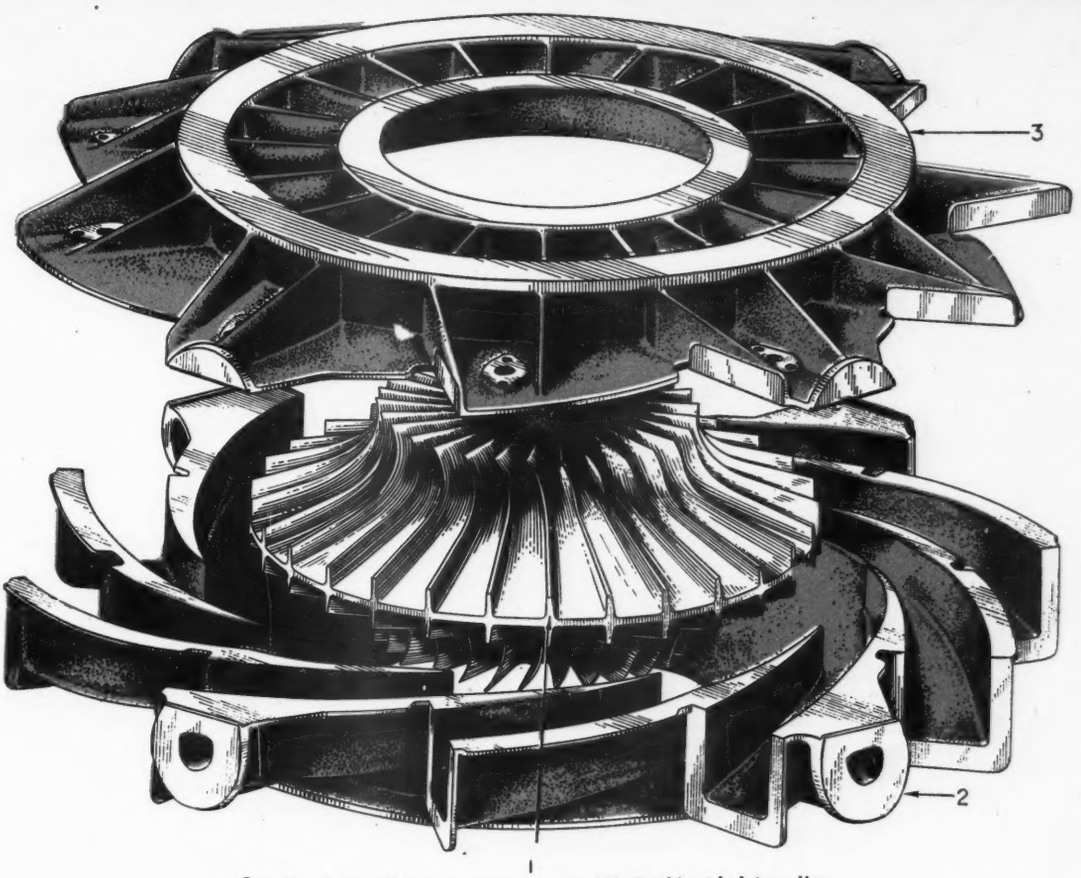
Power plant accessories. Accessories are located at the front of the unit and consist of the starter, starting fuel pump, main fuel pump, governor, lube and scavenger pump, tachometer generator, and the generator.

Lubrication. The engine is lubricated by a relatively simple dry-sump system. Mounted in the airplane is a 2 gal. (1.66 Imperial) oil tank with a direct connection at the bottom to the lube and scavenger pump on the accessory-drive assembly, which forces oil to the various parts of the machine. From the pump, the oil passes through a filter which removes sediment and foreign matter, and then proceeds through a relief valve where the pressure is properly limited for distribution. One line carries the oil to the accessory gear drive and casing through the ball support housing, and a second line delivers it to the front and rear bearings on the rotor shaft. If the pump should build up too much pressure, the lube relief valve, which is set at 9-11 lb. per sq. in., will open and bypass oil directly back into the inlet side of the lube and scavenger pump.

Each bearing is supplied with air which is bled from the compressor casing and directed through an air filter, where it is cleansed and then delivered to each bearing case. The air stream atomizes the oil to the rear bearing, causing an efficient distribution by spray lubrication. Air is introduced into the front bearing through an opening in a double oil seal. On one side, the air is forced through the seal to the bearing where it mixes with the oil to give complete distribution; on the other side, the air escapes to the atmosphere. The mechanical oil seal is thus rendered doubly effective.

Fuel system. This is a mechanical pressure system activated by a main engine-drive fuel pump aided by an external motor-driven booster pump which provides adequate flow of fuel to the main pump at high altitudes, compensating for the loss of atmospheric head. Operation of the system at starting differs slightly from normal running operation, in that main fuel pump discharge is bypassed by a check-and-relief valve to the starting fuel pump. By pressing the starter button, the starting fuel pump—geared to the starting motor—is set in operation and continues to function until the main fuel pump has reached a speed sufficient to establish a fuel pressure insuring self-acceleration of the unit. At this point, the check-and-relief valve isolates the starting fuel pump discharge, allowing flow directly from the main fuel pump. Fuel flows from the main fuel tank, passes through the booster pump and filter, and from there to the inlet connection on the main fuel pump.

During both starting and normal running operation, the fuel flows from the main fuel pump to a barometric valve which is so constructed that as altitude changes, fuel is bypassed back to the fuel tank to maintain approximately constant speed for a given throttle setting. From the barometric valve, fuel passes to the throttle valve, which is controlled by the throttle-valve quadrant in pilot's compartment, and then to the governor, connected through a train of gears to the engine rotor. The governor also functions to control the maximum



Details of centrifugal air compressor: (1) Double-sided impeller, (2) diffuser and lower casing, and (3) upper casing.

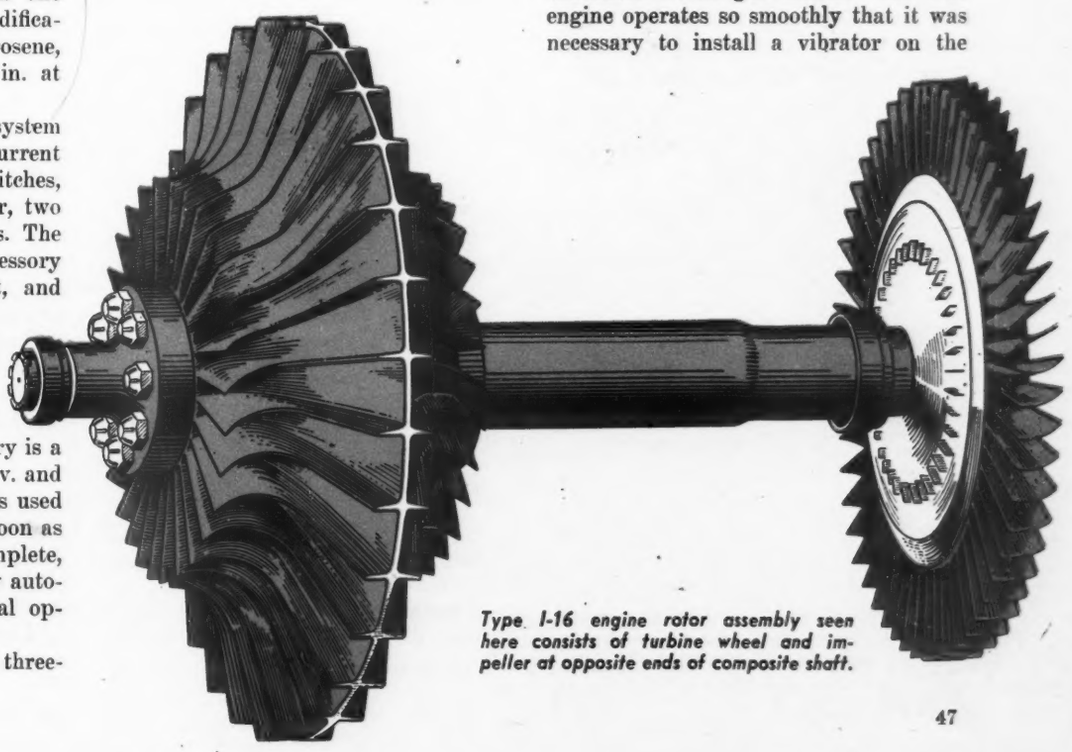
rotor speed by restricting the fuel flow, causing the barometric valve to pass more fuel back to the tank. From the governor, fuel is passed on to the stopcock, then to the drip valve and into the fuel manifold and burners. To stop flow of fuel, pilot closes the stopcock through the medium of a quadrant, thus cutting the supply to the burner manifold and stopping the unit.

Various types of fuel can be burned —kerosene, low or high octane gasoline, or furnace oil; but change from one fuel to another requires some modification in the fuel system. With kerosene, fuel pressure is 250 lb. per sq. in. at rated speed.

Electrical system. Electrical system consists of a generator, reverse-current relay, storage battery, control switches, undercurrent relay, starting motor, two ignition coils, and two sparkplugs. The generator—mounted on the accessory casing at the front of the unit, and geared to run at 3,800 to 6,000 rpm.—is a four-pole, compensated, commutating type, rated at 28.5 v. and 50 amp., and is cooled by ram air through an air-blast cover. The storage battery is a standard type with capacity of 24 v. and 17 amp.-hr. The ignition system is used only while starting the unit. As soon as burning of the fuel becomes complete, the starter and undercurrent relay automatically discontinue the electrical operation.

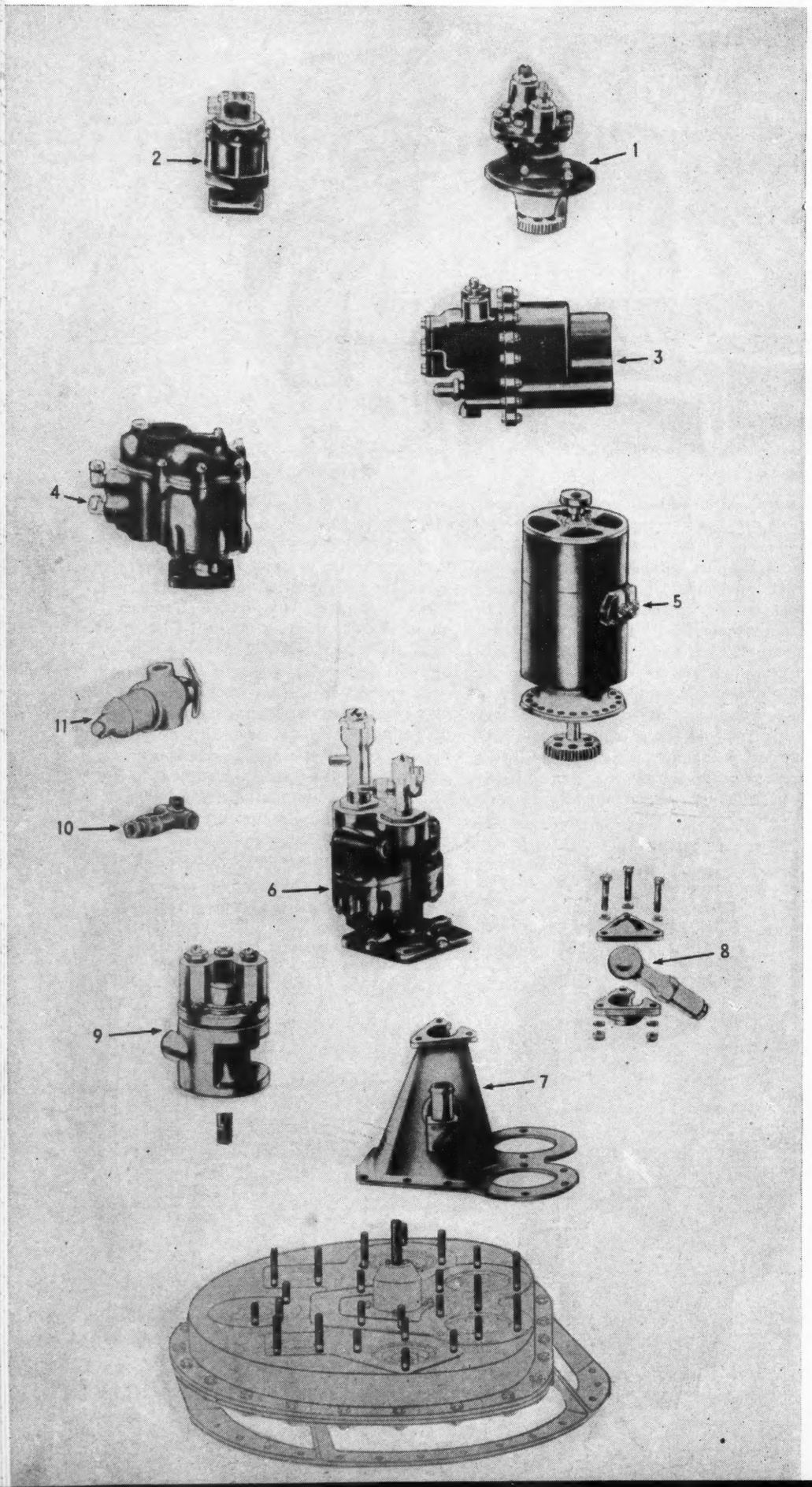
The I-16 turbojet incorporates a three-point support with two main trunnions in the horizontal plane and a front support in the vertical plane. Principal loads are carried by the two main trunnions. To minimize bending stresses transmitted from the airplane structure, only one of the trunnions is mounted to the airplane by a ball joint, the other being fastened by a slip joint. Front support is fastened by a ball-and-socket arrangement. Gyroscopic forces arising from pitching, sharp turns, and spin maneuvers are considerable, and were given due consideration in designing the three mounting supports. However, amplitude of vibration in the I-16 is so small that no vibration dampening is required in the mounting.

Compared to the conventional type of aircraft power plant, vibration produced by the turbojet unit is practically negligible. Smoothness of operation resulting from absence of vibration is one of the advantages and desirable characteristics of the gas turbine. The I-16 engine operates so smoothly that it was necessary to install a vibrator on the



Type I-16 engine rotor assembly seen here consists of turbine wheel and impeller at opposite ends of composite shaft.

Accessory components of I-16 jet engine: (1) Starting fuel pump, (2) tachometer generator, (3) barometric valve, (4) governor, (5) starter, (6) main fuel pump, (7) support housing, (8) ball support, (9) lube and scavenger pump, (10) lube relief valve, and (11) lube oil filter.



instrument panel to make the conventional instruments function properly. Normal vibration of the conventional airplane and engine combination is sufficient to cope with static friction in the instrument bearings, whereas the turbojet plane lacked this characteristic. And aside from smooth operation, the jet engine is much more quiet. This trait, coupled with absence of vibration, lessens pilot fatigue to a marked degree.

Ram efficiency affects operation of the I-16 much more than it does the operation of a conventional engine, hence great care has been given to the design of inlet ducting to insure a ram efficiency of at least 85% or better. Air flow requirement of this unit at rated rpm. is approximately 420 cfs.—varying with altitude and airspeed.

Installation in the P-59A has been very reliable and has demonstrated an excellent safety record. Experience has shown that the turbojet presents no greater fire hazard than does the conventional engine. Major potential fire hazards are fuel and exhaust systems, the lubrication system being considered only a minor hazard. Hot portions of the engine are adequately isolated from the airplane structure by insulating material. Potential hazard in the fuel system is being reduced by improvements in piping and fittings, and will be further minimized by a new fuel system being developed with a minimum number of separate accessories and connecting lines.

Performance Considerations

In general, jet propulsion is based on the reaction principle—for every action there is an equal and opposite reaction. However, this does not define the operation of the I-16 with sufficient accuracy, since it can be said that any propulsion in a fluid medium is based on imparting momentum to the fluid in such manner that the reaction of the imparted momentum furnishes the propulsive force. Rotation of a conventional propeller increases the momentum of the fluid passing through the propeller disk, and thus the propeller thrust can be considered as the reaction of the increase of momentum.

Propulsion of a rowboat, swimmer, or bird is also based on the principle of reaction. And to differentiate between jet and other methods of propulsion, it should be noted that jet propulsion exists when matter is ejected from the propelled body to create momentum. In the case of the I-16 turbojet, this matter is taken from the surrounding medium —the air—which is taken in at the front, heated by compression and the addition of fuel, and then ejected from the rear at high velocity. As previously stated,

thrust is developed through the high-velocity discharge.

Question of how fast this high-velocity discharge is, can be answered as follows: In a continuous flow process, where a fluid such as air is accelerated from an approach velocity, V_p, to a final velocity, V_j, a continuous reaction thrust, F, is obtained:

$$F = \frac{(W_a + W_f)V_j}{g} - \frac{W_a V_p}{g}$$

From a typical test data analysis of an I-16 unit operating at rated rpm. of 16,500 and corrected to standard conditions of temperature and pressure (see Table II at bottom of page),

$F = 1{,}670$ lb. static sea level thrust
$W_a = 32.9$ lb./sec. air flow
$W_f = .54$ lb./sec. fuel flow
g = acceleration due to gravity, 32.2 ft./sec.^{2}

Assuming the unit to be at sea level and at a standstill, V_p would be zero. Therefore, to solve for the jet nozzle discharge velocity, V_j, we have,

$$V_j = \frac{gF}{W_a + W_f} = \frac{32.2 \times 1{,}670}{32.9 + .54}$$

$$= \frac{53{,}774}{33.44} = 1{,}610 \text{ ft./sec.}$$

This high-velocity discharge flows from a jet nozzle 12.4 in. in dia.

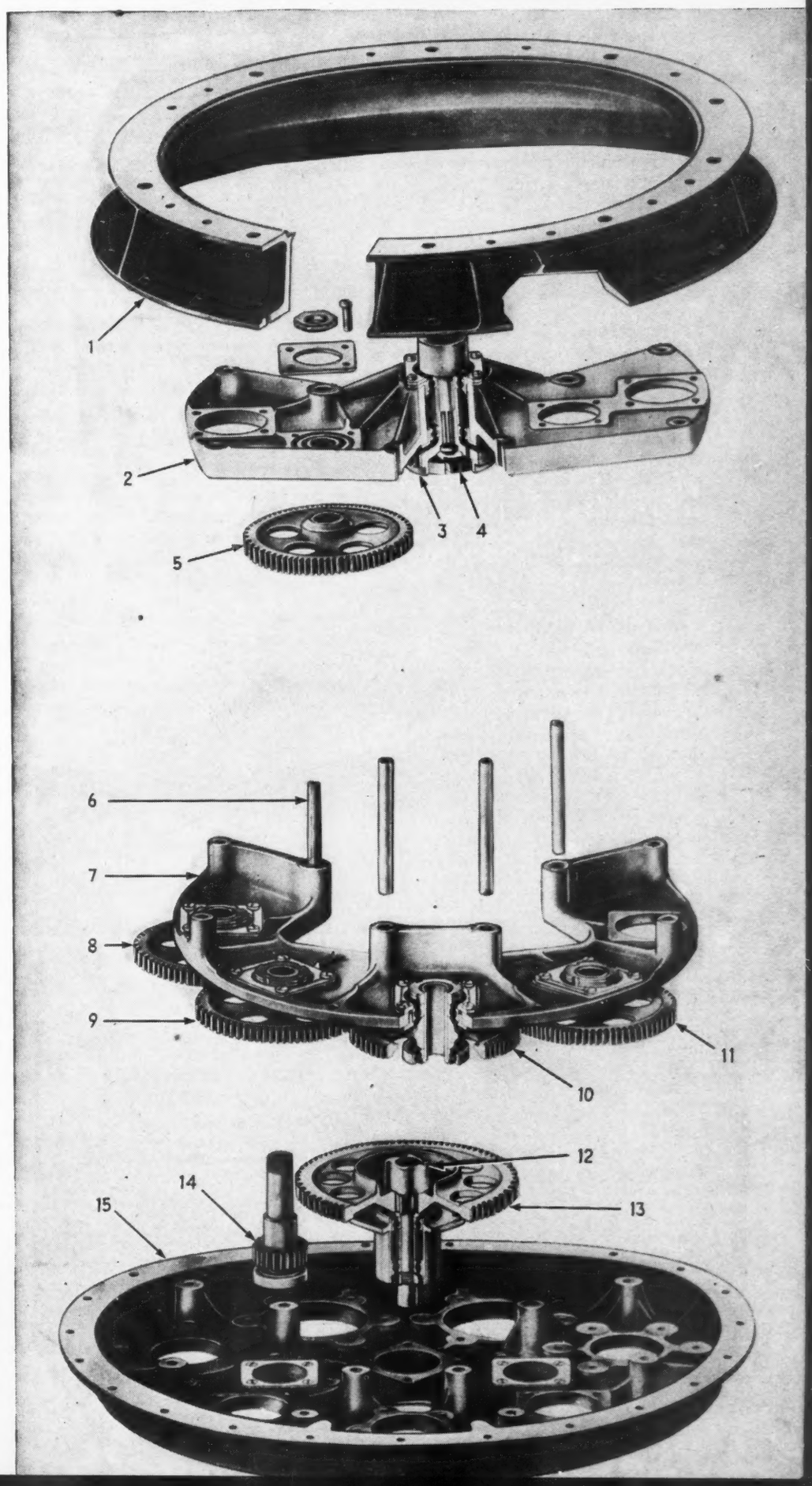
Since the turbojet engine is rated in lb. of thrust, instead of hp., it may be asked how the output of a turbojet can be compared with that of a conventional engine rated in bhp. This can easily be done by introducing the element of speed. Suppose we are interested in determining the approximate total bhp. being delivered by the two I-16 turbojets in a P-59A flying at a speed of 420 mph. at sea level.

First, we obtain from the accompanying thrust chart, the thrust obtainable from each engine at rated rpm. at sea level at 420 mph. From the intersecting dash lines, we obtain a thrust figure of 1,320 lb., and total thrust for the twin-engine P-59A is twice that value, or 2,640 lb. From the chart of thp. vs. thrust, we find that at 420 mph. and a thrust of 2,640 lb., the turbojets are supplying 2,900 thp. This is an approximate figure, but sufficiently accurate for all practical purposes. To obtain bhp., thp. is divided by propeller

TABLE II—Turbojet Average Peformance at 16,500 rpm. with Standard Inlet Conditions of 14.7 lb. per sq. in., 59 Deg. Temperature, and 0 Ram

Thrust	1,670 lb.
Fuel flow	54 lb./sec.
Sfc.	1.18 lb./lb. of T/hr.
Exhaust temp.	1,180 deg. F.
Compression ratio	3.75
Compressor discharge temp.	380 deg. F.
Combustion pressure drop	1.92 lb./sq. in.
Turbine inlet temp.	1,485 deg. F.
Air flow	32.9 lb./sec.

Exploded view of accessory drive assembly: (1) Aft casing, (2) aft spider, (3) main drive pinion, (4) clutch pawl, (5) accessories drive gear—first reduction, (6) hollow dowel, (7) intermediate spider, (8) main fuel pump drive gear, (9) governor drive gear, (10) lubrication pump drive gear, (11) tachometer generator drive gear, (12) clutch, (13) starting gear, (14) accessories drive pinion—second reduction, and (15) forward casing.



efficiency. At the speed in question, a propeller efficiency of approximately 80% would be achieved. Hence, the equivalent bhp. output of the two turbojets under the conditions stated would be 2,900/80, or 3,620.

By reference to these two charts, it can be seen that the thrust available is fairly constant throughout the speed range, especially at altitude. This means that fuel is burned at practically a constant rate. Hence, to take full advantage of this available thrust, it is most important that the airplane in which the turbojet is installed should be as clean as possible aerodynamically.

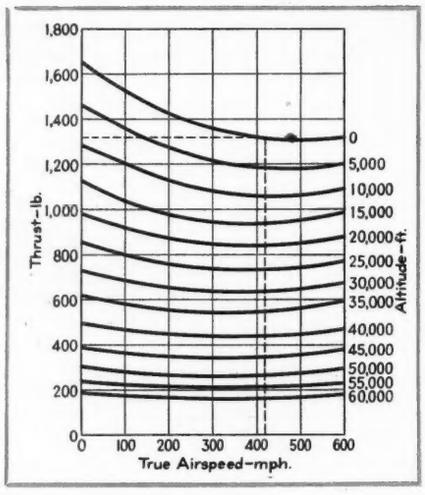
Metallurgical Factors

To the metallurgist must go a large measure of the credit for the success of the turbojet unit as we know it today. One means of increasing the efficiency of this type of power plant will be by raising the temperature of the gas at the turbine inlet. This increase in temperature can only be achieved if improved temperature-resistant materials are made available. The importance of advancements which have already been made cannot be too strongly emphasized. If the metallurgist had been unable to provide materials suitable to withstand the high temperatures and tremendous centrifugal stresses anticipated by the design engineers for this new type plant, the I-16 and other improved models would not have materialized.

Turbine wheels are massive and rotate at terrific speed at high temperature. This presents many problems—the most difficult being to develop a material with high yield strength for the center of the wheel and high rupture strength at the rim. Materials chosen for the first turbine wheels (disks) were chromium-nickel alloys such as 17W and Alpha CB. These were replaced by the Timken wheel now used on production units.

Selection of alloys for turbine buckets is equally critical and is based on rupture strength at 1,500 deg. F. and up. As rupture strength increases, forgeability usually decreases. And as forging difficulties increased, more and more attention was given to the development of cast buckets. Several types of heat-resistant alloys, which have proved so successful in the turbosuperchargers used in our high altitude planes, were tried as turbine bucket material for the IA and I-16 turbojets. Among these are Vitallium, a cobalt-chrome-molybdenum alloy; 19-9-DL, a chrome-nickel alloy having high rupture strength; and Hastelloy B, high in nickel and molybdenum content.

A large amount of development testing has been done with both forged and cast buckets, and these were attached to a turbine wheel by welding or by mechanical means, such as the dovetail or "Christmas tree" attachment used on the British unit. For production-engine bucket material, Hastelloy B was chosen as the best available, and buckets made from this material are forged and attached to the turbine wheel by the Christmas tree method.



Type I-16 turbojet thrust at 16,500 rpm. (Based on NACA standard air ram efficiency 85%.)

Turbine nozzle blades are made of either molybdenum or columbium stabilized 18-8 stainless steel. These alloys have good welding characteristics and are easily forged. Blades are fastened into the diaphragm by insertion between inner and outer ring, then fillet-welded in place.

High temperature sheet metal parts—expansion bellows, outer casings, inner liners and inter-connectors of the combustion chambers, elbows, tailcone, and other parts—are made of heat-resistant material ranging from 0.015 to 0.030. Inner liners and inter-connectors are usually made of Inconel, whereas other sheet metal parts are made of stabilized 18-8 stainless steel.

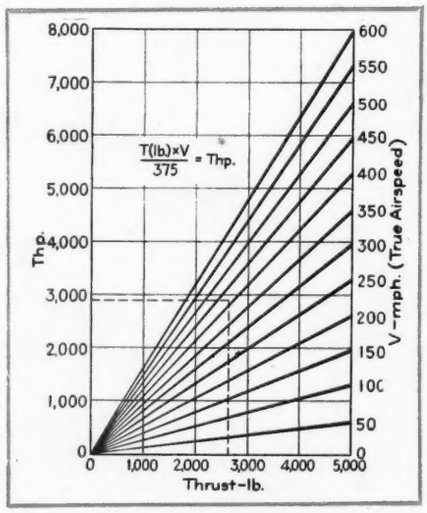


Chart of thrust horsepower vs. thrust.

The turbojet operates best at a point near its maximum output condition. Operation of its compressor at reduced speeds would mean an alarming decrease in output coupled with an increase in specific fuel consumption. For efficient operation, the turbojet must be associated with high speeds—speeds usually beyond that obtainable with the conventional engine-and-propeller combination. Or, to express it another way, for the best results an airplane equipped with turbojet engines must fly within 10% or 15% of its maximum speed. The conventional engine, on the other hand, behaves differently, since to obtain the most economical operation in mi. per gal. of fuel consumed, engine output can be reduced to 50% or even 40% of its rated power. Continuous operation of the conventional engine at a point near its rated output means abnormally high specific fuel consumption and short engine life.

For efficient operation the turbojet must also be associated with high altitude, since the lower temperature at altitude increases the compression ratio of the compressor (as much as 25 percent at 40,000 ft.) and decreases specific fuel consumption of the engine. As altitude is increased, airplane drag is decreased, which, in turn, results in a substantial decrease in power required for the same forward speed. Obviously, all types of aircraft and missiles, no matter how propelled, benefit from decreasing air density to the extent that air resistance or drag decreases. Add these factors together and it will be evident that airplane endurance can be greatly increased for the same fuel consumption when flying at high altitude and at no sacrifice in speed.

For example, when flying at maximum speed at sea level, the P-59A has an endurance of approximately 35 min. with normal fuel load. However, when flying at that same speed at 40,000 ft. with the same amount of fuel available at the start of the flight, its endurance, including climb to altitude, is increased to 100 min. This means that in a jet propelled plane, such as the P-59A, one can fly almost three times as far if immediately upon takeoff a climb is made to a suitable altitude.

The turbojet will supplement and eventually replace the conventional engine—first in fightercraft, then in super-speed bombers, and finally in transport, both military and civil. At the present state of development, however, it is difficult to foresee any application of jet propulsion to private flying in the immediate future.

DESIGN ANALYSIS OF

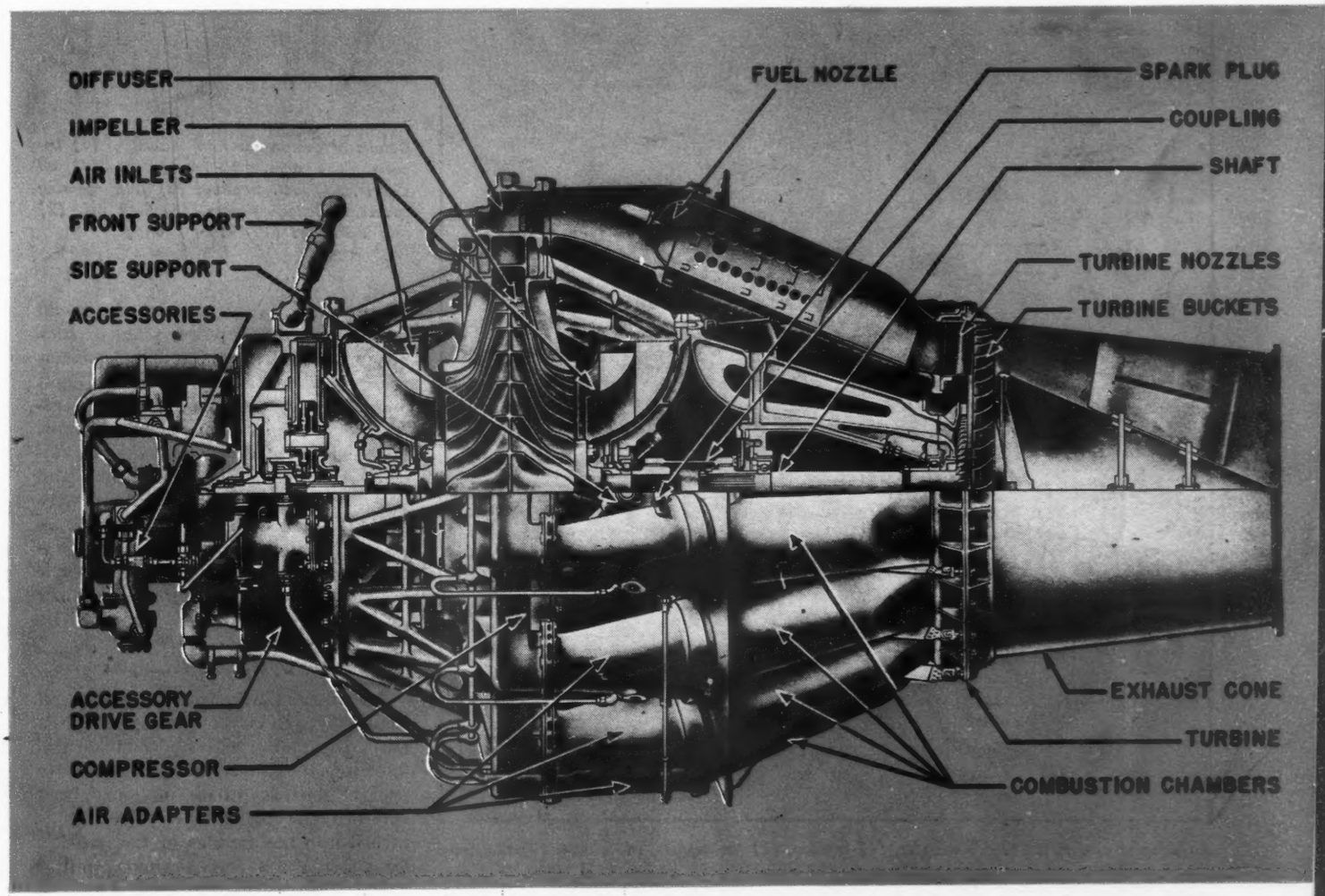
GENERAL ELECTRIC TYPE I-40 JET ENGINE

EARLY IN 1943, at the request of the AAF, the General Electric Co. started the study of a jet propulsion gas turbine to have considerably higher rating than any jet propulsion gas turbine then in existence.

At the request of Col. D. J. Keirn, ATSC, and the company's Engineering Div. Development Committee, this original design study was aimed to create a unit having 3,000 lb. static thrust. This value was later revised to 3,500 lb., and still later it was decided that a gas turbine with 4,000 lb. static thrust at sea level standard conditions would be the objective. The project unit became known as the Type I-40 (military version J-33) jet propulsion gas turbine (turbojet), and in June, 1943, it was decided to proceed with the development.

By **DALE D. STREID,** *Aircraft Gas Turbine Div., General Electric Co.*

In this initial and revealing analysis of the high-thrust turbojet unit powering the AAF's fastest craft—Lockheed's P-80 Shooting Star—basic details of construction features and performance are presented . . . 17th in Aviation's unparalleled series of engineering studies.



Cutaway view of GE Type I-40 turbojet engine.

235745

Three months were spent completing the design and making drawings for the manufacture of the first development unit. As soon as the drawing for a part was completed, production of the unit was commenced. And in Jan., 1944, the first I-40 power plant was completed, delivered to test, and run up to 8,000 rpm. In subsequent tests, the turbine was run at various speeds up to 8,700 rpm.—a limit observed because the buckets had an unfavorable tilt and were considered unsatisfactory for operation at higher speeds.

In a month, after a new turbine wheel had been installed, the following performance data—which have been corrected to standard conditions of 14.7 lb. per sq. in. and 59 deg. F. at the compressor inlet—were obtained:

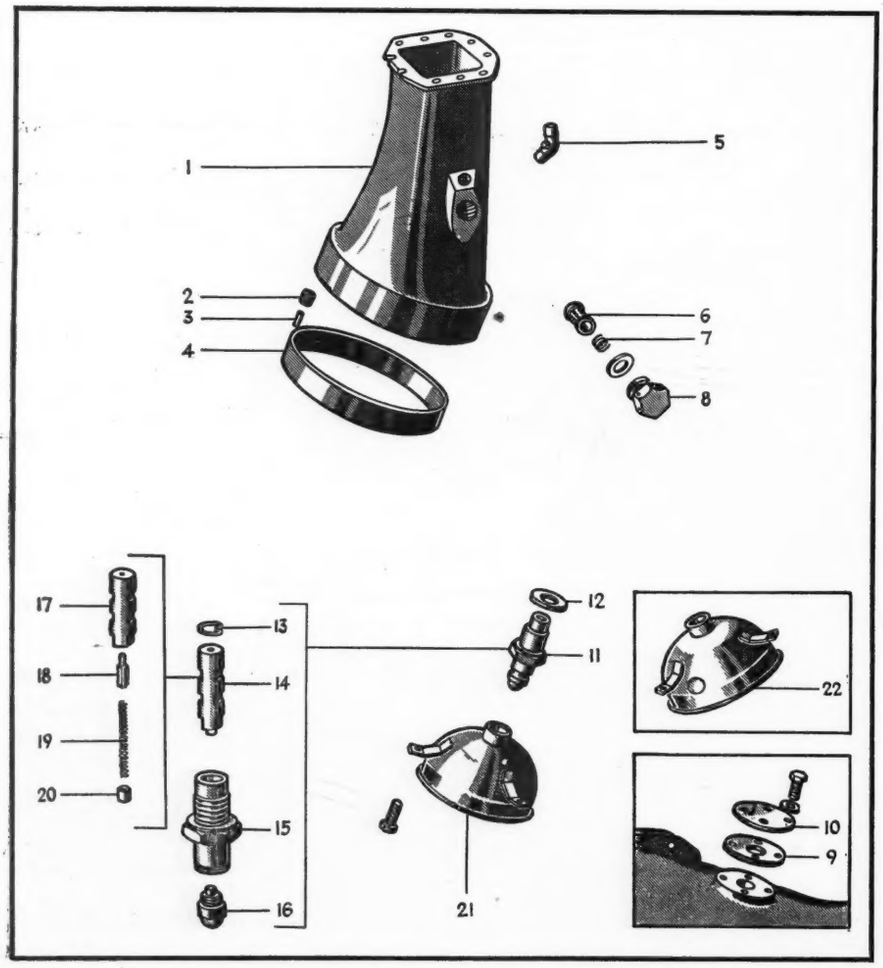
Speed	11,500 rpm.
Thrust	4,200 lb.
Fuel flow	5,070 lb. per hr.
Exhaust temp.	1,300 deg. F.
Jet dia.	18.2 in.

So far as was known at the time, 4,200 lb. was the highest thrust ever obtained with a jet propulsion gas turbine. Performance data were generally very gratifying, but the exhaust temperature was much higher than desired and, accordingly, the jet dia. had to be increased to 19 in. to keep the exhaust temperature below the desired limit of 1,200 deg. F.

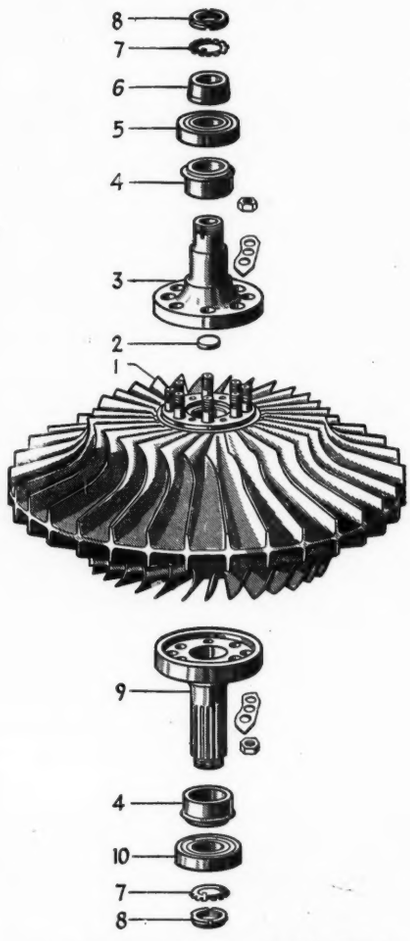
Additional I-40 development units were soon completed—making a total of four. First three were used for performance and endurance tests and never for flight. The fourth was shipped to Lockheed at Burbank, Calif., and was there installed in the first XP-80A Shooting Star.

First trial of the Lockheed XP-80A—made at Muroc, Calif., on June 10, 1944, less than 1 yr. after the start of the development project—was a flight of about 30 min. to an altitude of 10,000 ft., and operation of I-40 jet engine was considered very satisfactory.

Since the first flight of the Shooting Star, further development of the I-40 has proceeded very rapidly. As would be expected with a power plant of such new size and design, many problems arose following factory testing and flight operation. Among those difficulties requiring considerable attention were: Exhaust cone buckling, sticking of automatic controls, carbon formation, and fuel pump wear. These details were brought under control, and manufacture of the I-40 gas turbine proceeded fundamentally in accordance with the same design laid down during the Summer of '43.



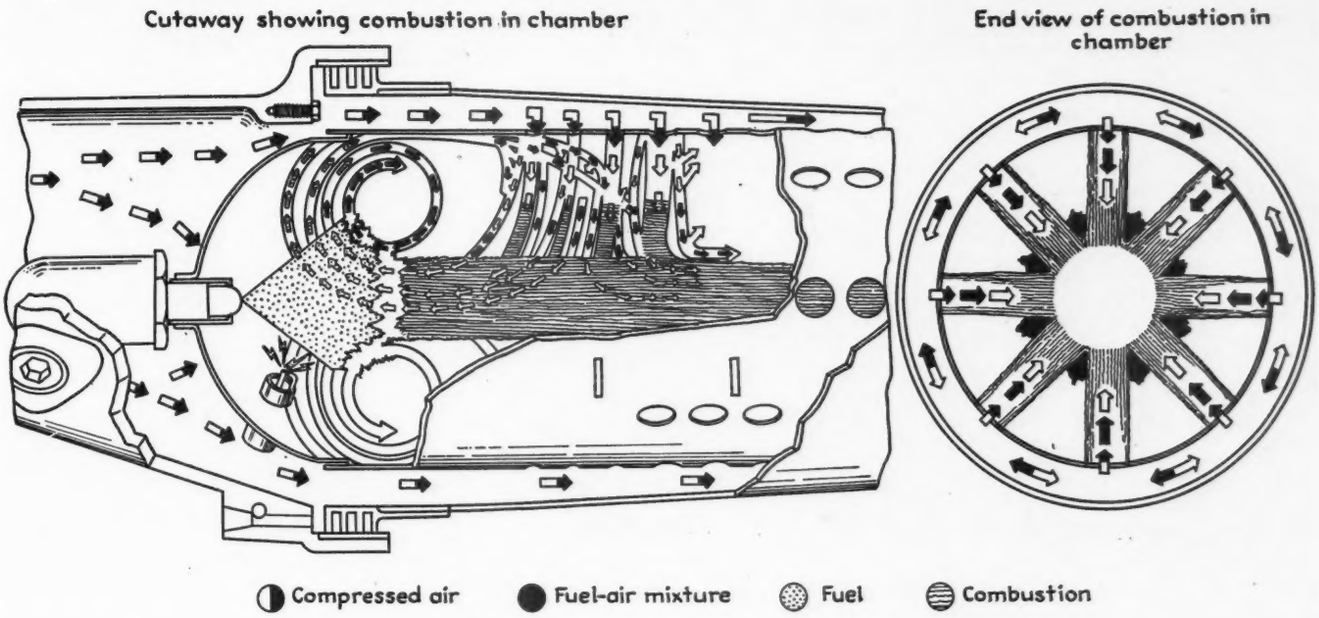
Air adapter assembly: (1) Air adapter, (2) bushing, (3) locking pin, (4) sleeve, (5) fuel inlet fitting, (6) filter, (7) spring, (8) pipe plug, (9) adapter cover gasket, (10) cover, (11) fuel nozzle, (12) nozzle gasket, (13) lock ring, (14) valve, (15) body, (16) fuel tip, (17) barrel, (18) pin, (19) spring, (20) plug, (21) plain dome, and (22) sparkplug dome.



Details of compressor rotor assembly: (1) Impeller, (2) plug, (3) front shaft, (4) oil slinger, (5) ball bearing, (6) front bearing spacer, (7) lock washer, (8) lock nut, (9) rear shaft, and (10) roller bearing.

I-40 Operation Principles

Air enters the compressor of the jet engine through circumferential inlets on the front and back of a double-sided impeller, the inlets being screened to prevent particles of dirt or stone from entering the air intake. The air is turned into the annulus of the impeller by guide vanes and a single splitter vane. Design of the inlet does not impart any pre-swirl to the air as it

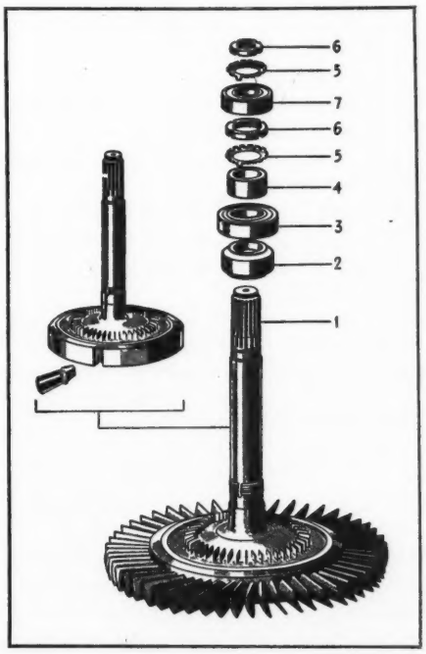


Cutaway diagram of combustion chamber, showing mixing and combustion of fuel and air.

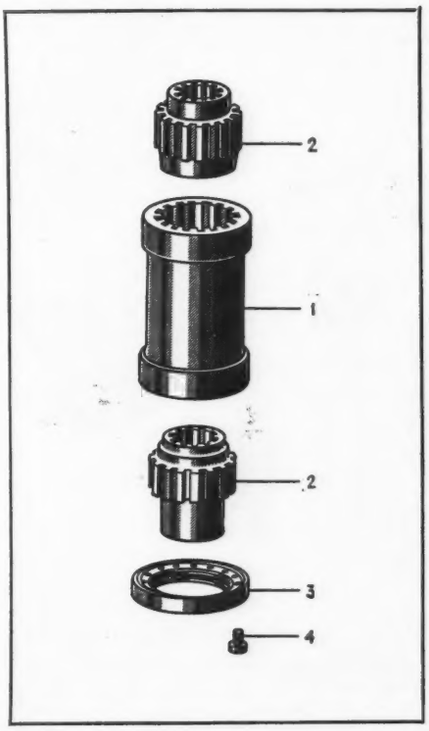
enters the impeller. The impeller is a solid aluminum forging with milled blades having inlet sections bent to match incoming airflow. Discharge from the impeller enters 14 equally spaced diffuser passages, and at the end of each is a Wirt-type elbow containing four vanes which turn the air 90 deg. into the compressor discharge.

Air from the compressor outlets is conducted to the combustion chambers by cast air adapters, which carry the fuel nozzles, domes (end caps) of the combustion chamber, and the spark-plugs.

The 14 combustion chambers are of the through-flow type, with air entering from the compressor end and leaving at the turbine end in the same direction. Combustion is controlled by holes in

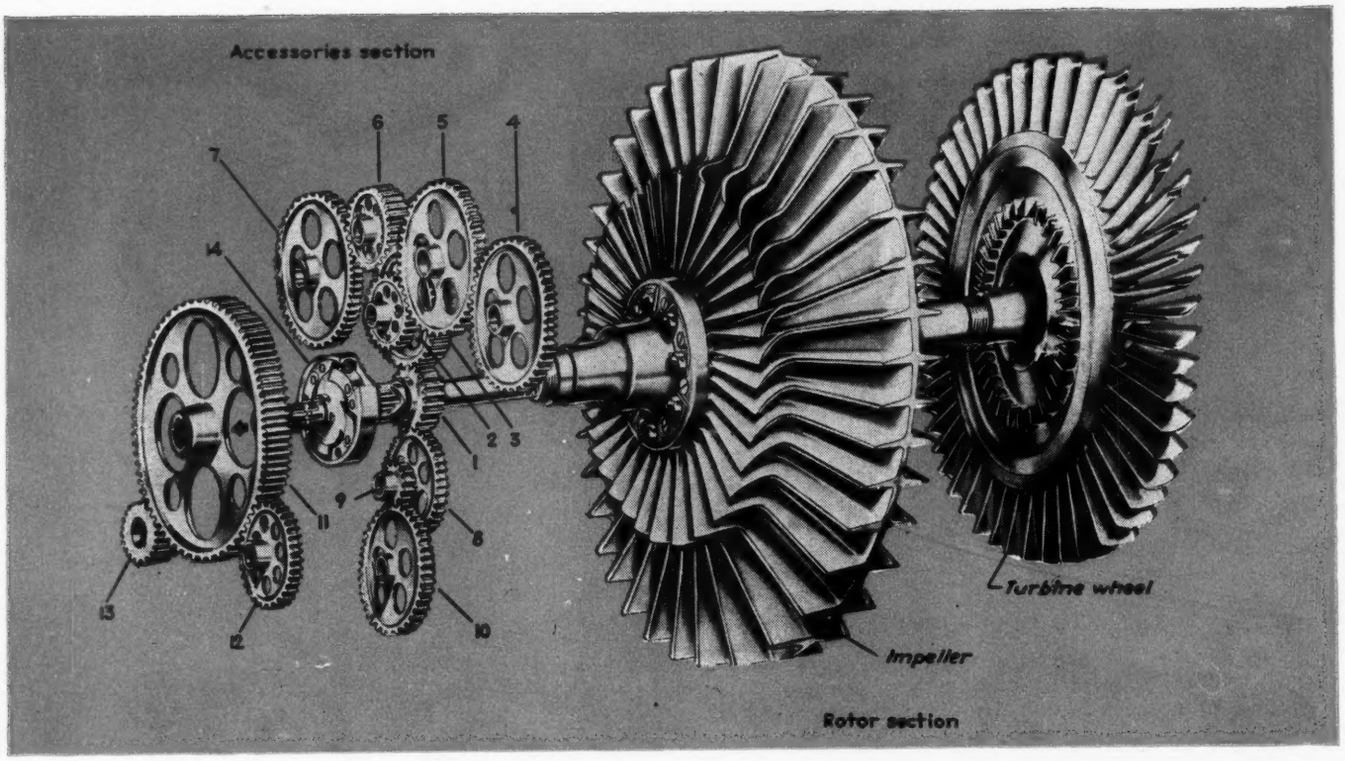


Details of turbine rotor construction: (1) wheel, shaft, and bucket assembly, (2) oil deflector, (3) roller bearing, (4) rear spacer, (5) lock washer, (6) lock nut, and (7) ball bearing.

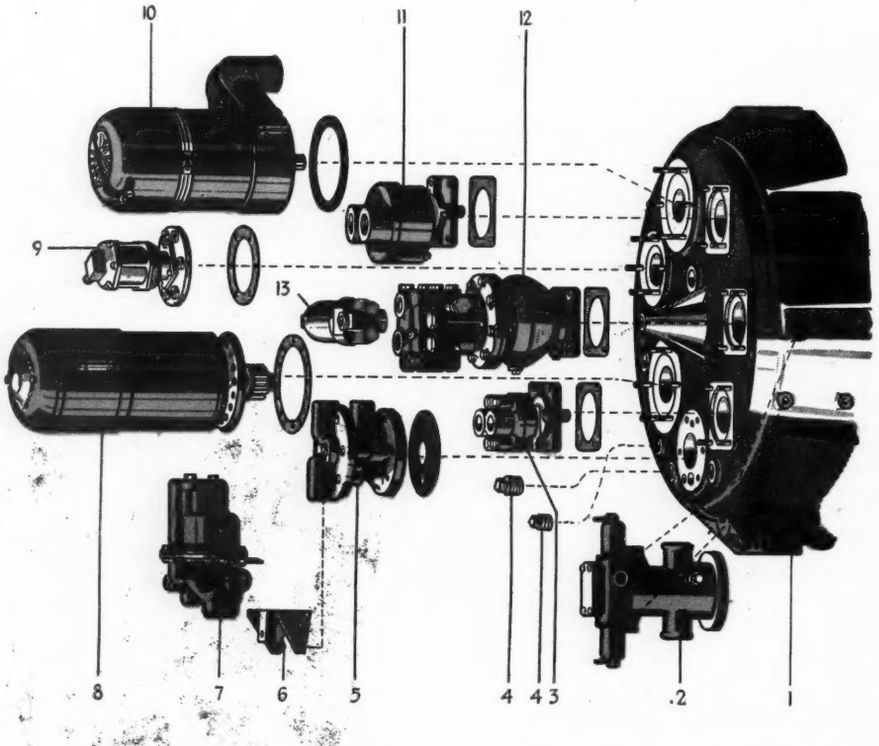


Coupling assembly: (1) Sleeve, (2) hub, (3) ring, and (4) capscrew.

Seen here is exhaust cone assembly and aluminum foil-bronze mesh insulation pad.



Accessory drive gear train and drive from turbine and compressor rotors. Gear identification: (1) Main accessories pinion, (2) upper pinion, (3) upper idler, (4) governor, (5) main fuel pump, (6) generator, (7) tachometer, (8) lower idler, (9) lower pinion, (10) lube pump, (11) starter, (12) starting fuel pump, and (13) starter shaft. Starter clutch is at (14).



Exploded relation of accessories: (1) Accessory drive gear casing, (2) control valve, (3) starting fuel pump, (4) plug, (5) lube and scavenger pump, (6) bracket for barometric valve, (7) barometric valve, (8) starter, (9) tachometer-generator, (10) generator, (11) main fuel pump, (12) governor, and (13) lube oil filter.

the liners, and outer tubes are cooled by compressor discharge air before it enters the liners. A thin film of air travels the full length of the liners to provide cooling at the liner ends at the turbine inlet. During starting, ignition is obtained from two sparkplugs mounted in diametrically opposite air adapters, and ignition for the other combustion chambers is obtained by utilizing cross ignition tubes.

Turbine nozzle ring—containing 48 blades—directs the hot gas onto the turbine wheel equipped with 54 buckets. Exhaust from the turbine wheel is diffused in an exhaust cone to a lower velocity in the circular exhaust pipe of constant diameter, which carries the gas to a jet nozzle. In some installations, the exhaust pipe and exhaust nozzle have been combined into an exhaust pipe of constant taper from the exit diameter of the exhaust cone to the proper jet nozzle diameter.

Structural Details

Table I gives some of the fundamental design data of the I-40 jet engine.

Mechanical construction of the engine consists of five major subassemblies bolted together to form the complete assembly. These subassemblies are:

1. Accessory drive
2. Compressor
3. Turbine and combustion chambers
4. Exhaust cone
5. Air adapters

Table I—Fundamental Design Data

Impeller dia.	30 in.
Impeller inlet dia.	18¼ in.
Impeller hub dia.	8 in.
Diffuser throat area	75 sq. in.
Fuel nozzle size	40 gal. per hr. @ 100 lb. per sq. in.
Turbine nozzle area	121.3 sq. in.
Turbine pitch dia.	22 in.
Turbine nozzle & blade height	4 in.
Exhaust pipe dia.	21 in.
Jet nozzle dia.	19 in.
Maximum overall dia.	48 in.
Overall length	101½ in.
Average weight	1,820 lb.
C. G. (aft of trunnion)	2 in.

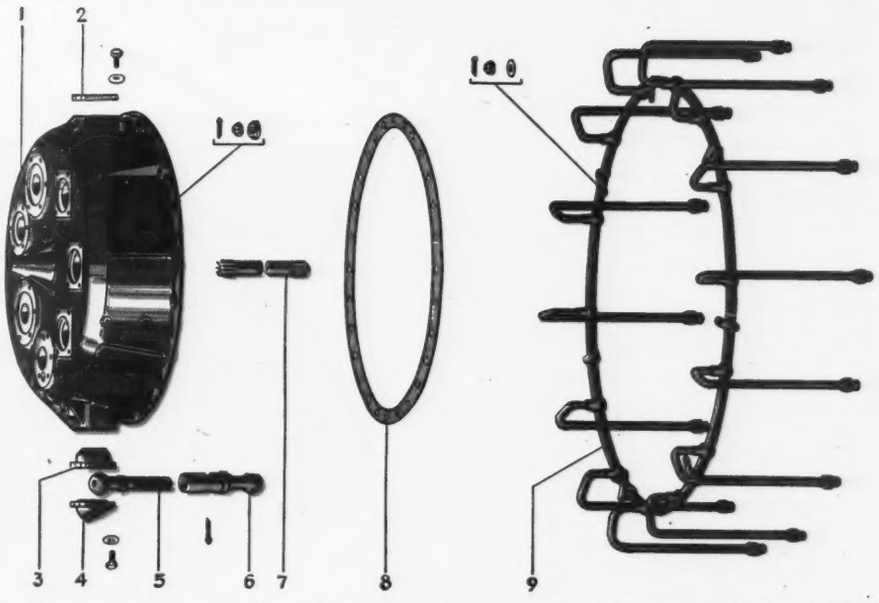
Each of these is a complete unit operative in itself so far as its particular function is concerned, and each is interchangeable in all I-40 gas turbines without matching, balancing, or special fitting. First three subassemblies may be tested independently—a distinct advantage in production, maintenance, and field service.

The complete assembly is mounted on two horizontal trunnions and a front support. The trunnions project outwardly between air adapters at the rear air inlet very near to the center of gravity of the gas turbine. Front support can be mounted on either the top or the bottom of the gear casing, depending upon the installation.

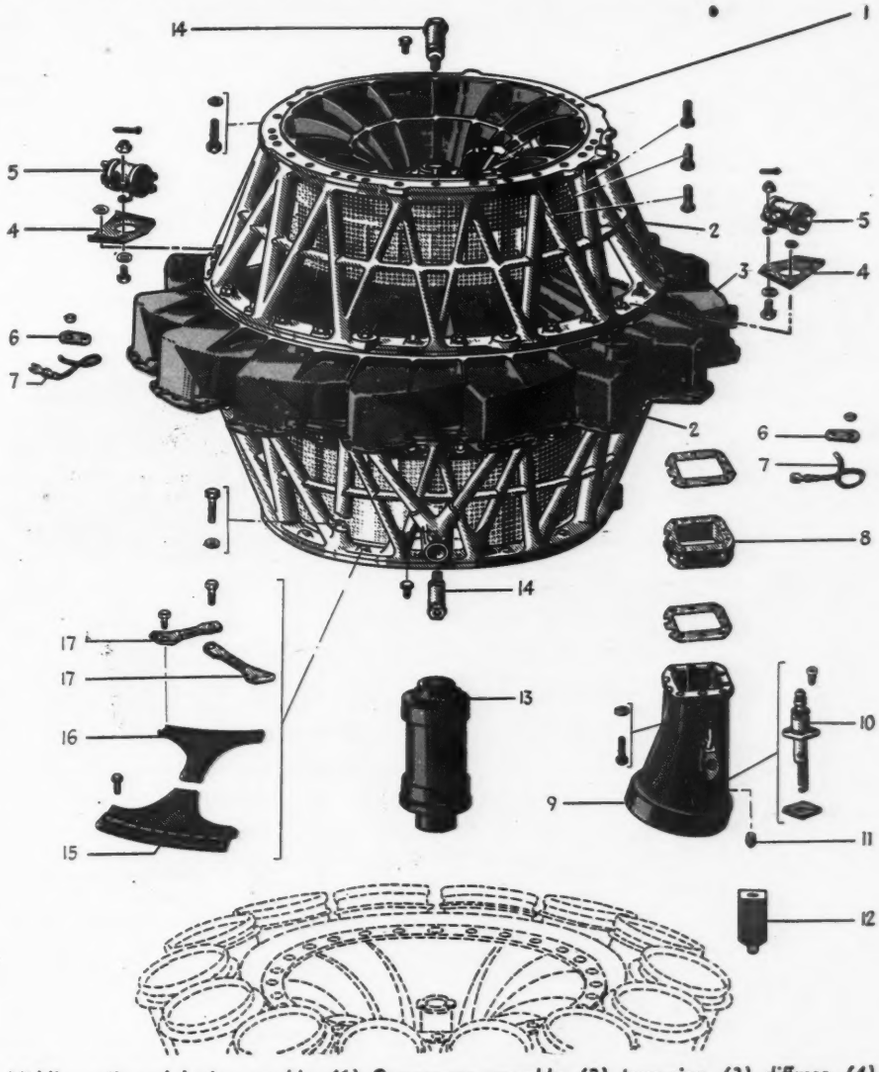
Accessory drive consists of an outer casing (which carries the various accessories) and a rotor cage which fits in the casing (carrying all the gears and most of the bearings). The outer casing also serves as the oil reservoir for the gas turbine.

Compressor rotor is comprised of an impeller with stub shafts bolted on each side. Front shaft is carried by a ball bearing and rear shaft is carried by a roller bearing. Axial clearance is adjusted by a sliding ring which carries the outer race of the ball bearing. These bearings are carried in support casings which bolt to the flanges of the accessory drive on one end and the turbine and combustion assembly on the other end. Truss rings are fastened to these same flanges and span the front and rear air inlets, supporting the compressor casings and the diffuser. The diffuser is a box-type single casting with the elbows and turning vanes cast integrally, and compressor casings form the side walls of the impeller and support part of the inlet guide vanes.

Turbine and combustion chamber assembly consists of a turbine bearing support, turbine rotor, and a set of combustion chambers. The turbine rotor has a shaft flash-welded to the wheel and buckets dovetailed to the rim of the wheel. The rotor is carried by a roller bearing at the rear end and a ball bearing at the front end. The axial clearance is adjusted in the same manner as for the compressor rotor—by a slid-

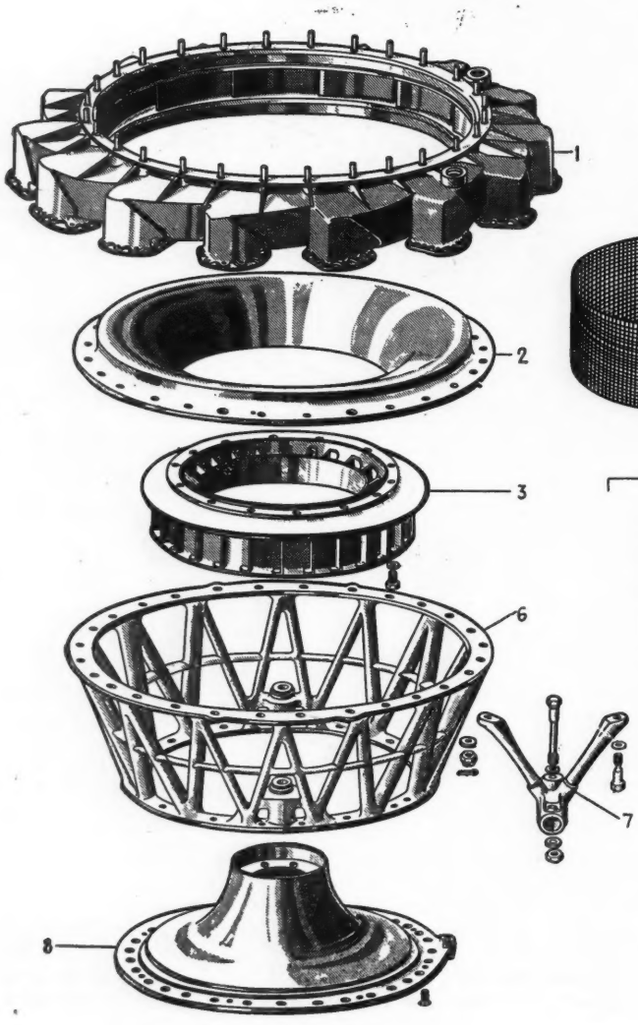


Front section of basic assembly: (1) Accessory drive gear casing, (2) support pad plate, (3) ball seat, (4) ball cap, (5) male support, (6) female support, (7) coupling shaft, (8) bearing support gasket, and (9) fuel manifold assembly.

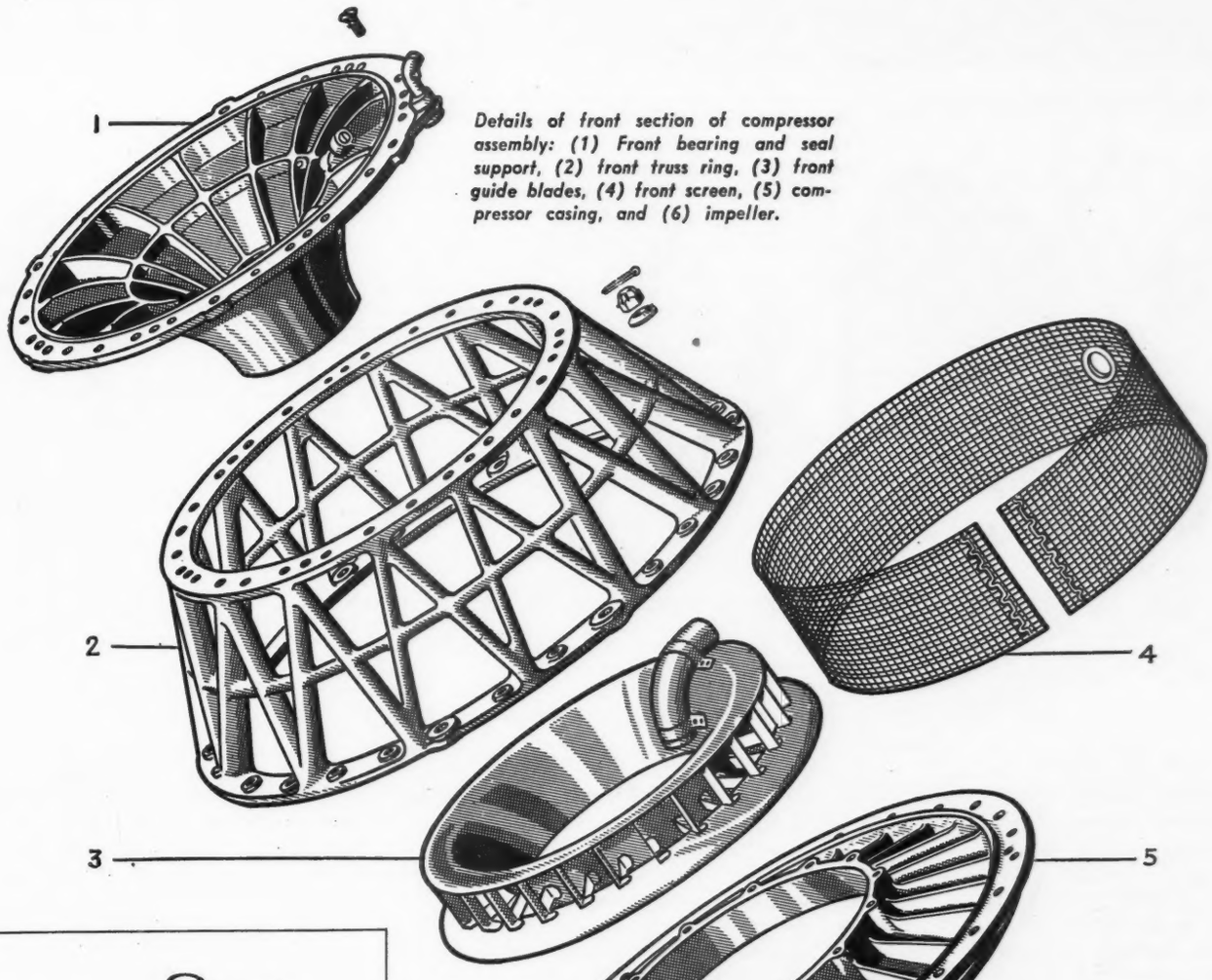


Middle section of basic assembly: (1) Compressor assembly, (2) truss ring, (3) diffuser, (4) ignition coil bracket, (5) ignition coil, (6) ignition lead bracket, (7) cable, (8) air adapter spacer, (9) air adapter, (10) sparkplug, (11) pipe plug, (12) drain valve, (13) coupling, (14) trunnion spindle, (15) outer sector, (16) inner air baffle sector, and (17) air adapter bracket.

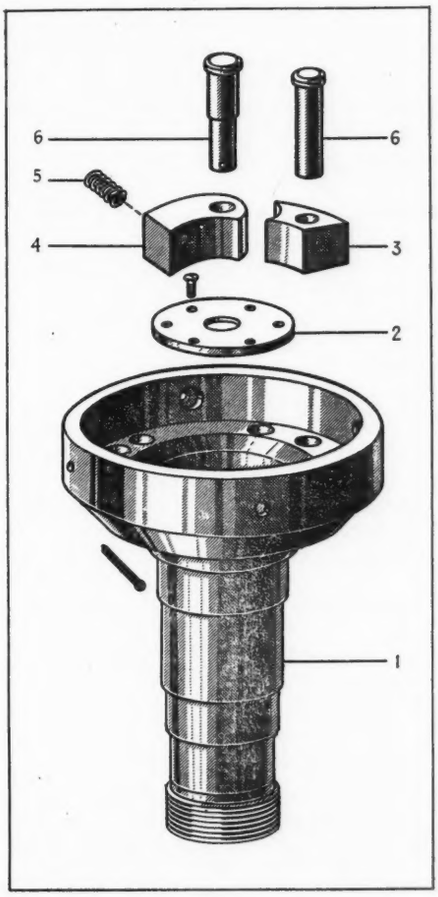
Rear section of basic assembly: (1) Bearing support gasket, (2) turbine unit assembly ,(3) piston ring, (4) combustion chamber, and (5) exhaust cone.



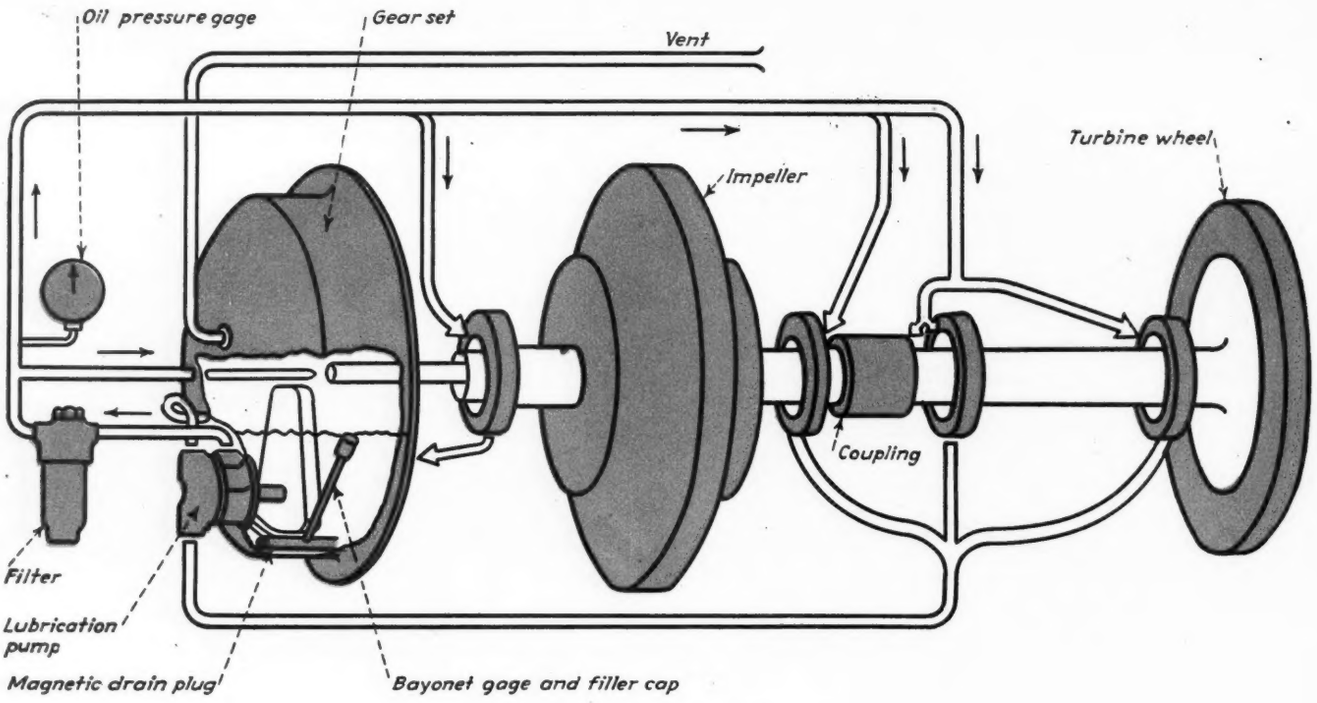
Details of rear section of compressor assembly: (1) Diffuser, (2) casing, (3) rear guide blades, (4) rear screen, (5) hook, (6) rear truss ring, (7) trunnion support, and (8) rear bearing and seal support.



Details of front section of compressor assembly: (1) Front bearing and seal support, (2) front truss ring, (3) front guide blades, (4) front screen, (5) compressor casing, and (6) impeller.



Clutch assembly: (1) Clutch shaft, (2) retaining plate, (3) thrust block, (4) pawl, (5) clutch spring, and (6) flat-head pin.



Schematic diagram of lubrication system.

ing ring which carries the outer race of the ball bearing. The bearing support is covered with a shroud so that cooling air can be brought along the inner wall, then passing out through the cooling fan on the front side of the turbine wheel, cooling the turbine wheel, and finally emerging through the spaces of the combustion chambers.

The 14 combustion chambers are arranged around the turbine with their axis conical, joining together at the turbine inlet to provide an annular flow of hot gas. Turbine nozzles are mounted between two rings around the discharge of the combustion chambers. At the entrance end of each combustion chamber, a piston ring joint is used to allow for expansion resulting from heating. The flange of the turbine bearing support (which joins to the compressor assembly) and the flange around the turbine nozzle ring (which joins to the exhaust cone) are connected by tie straps made of Invar to insure that there will be no relaxation because of heat.

Outer cone of the exhaust cone assembly supports an inner cone by four struts and is insulated on the outside by an aluminum foil-wire mesh blanket. Outer cone large front flange acts as a shroud for the turbine buckets, and small rear flange connects to the exhaust pipe.

Air adapters which are aluminum castings carrying the fuel nozzles, domes of combustion chambers, and sparkplugs, are so designed that they can be removed from the turbine for inspection of fuel nozzles, domes, and liners.

Lubrication system incorporates an oil pump comprised of two elements—lube and scavenger. The lube element draws oil from the reservoir in the bottom of the accessory drive casing and passes it through a filter for delivery to the four main bearings, to the coupling sleeve between the turbine and compressor rotor, and to the quill shaft splines of the accessory drive. Oil from the front compressor bearing and accessory drive quill shaft drains directly into the oil reservoir. Oil from the other three main bearings and coupling sleeve drains into a sump from which it is drawn by the scavenger element, then delivered back to the oil reservoir. At a turbine speed of 11,500 rpm., the lube pump has a displacement of about 3 gpm. and the scavenger pump about 10 gpm. Last-chance screens are provided immediately ahead of all oil jets to prevent plugging.

Gears and bearings in the accessory drive are lubricated by splash from the gear which drives the lube and scavenger pump. This gear—located under the oil level—is protected by a shroud, and a small amount of oil is admitted to the inside of the shroud through an orifice in the bottom. Thus, the quantity of oil for lubricating the gears and bearings is metered and the oil in the reservoir is not churned into foam by the gears. The gear casing is vented by a pipe to a point aft of the baffle on the rear side of the rear compressor inlet. The vent opens into the accessory drive casing near the center of the front side, and thus, oil will not run out of the vent at any attitude of the gas turbine.

Performance Data

Takeoff and military rating of the I-40 is for 15 min. at 11,500 rpm. Normal rating is for continuous operation at 11,000 rpm. Idling speed is minimum continuous operating speed and is for 3,500 rpm.

In the accompanying charts, plots of thrust, fuel flow, specific fuel consumption, and exhaust temperature are shown for the 21 I-40 gas turbines built at GE's Lynn plant. Actual test points are plotted and corrected to standard conditions, and the single curve gives the average of the data.

Table II lists the average performance data on the same basis of the curves, from which values for thrust, fuel flow, specific fuel consumption, and exhaust temperature are taken.

Table II—I-40 Gas Turbine Average Performance Data at 11,500 rpm. with Standard Inlet Conditions of 14.7 lb. per sq. in., 59 Deg. F. and O Ram.

Thrust	4,000 lb.
Fuel flow	4,740 lb. per hr.
Specific fuel consumption	1.185 lb. per hr. per lb. thrust
Exhaust temp.	1,170 deg. F.
Compression ratio	4.126
Compressor discharge temp.	413 deg. F.
Combustion pressure drop	3.18 lb. per sq. in.
Turbine inlet temp.	1,492 deg. F.
Air flow	79 lb. per sec.

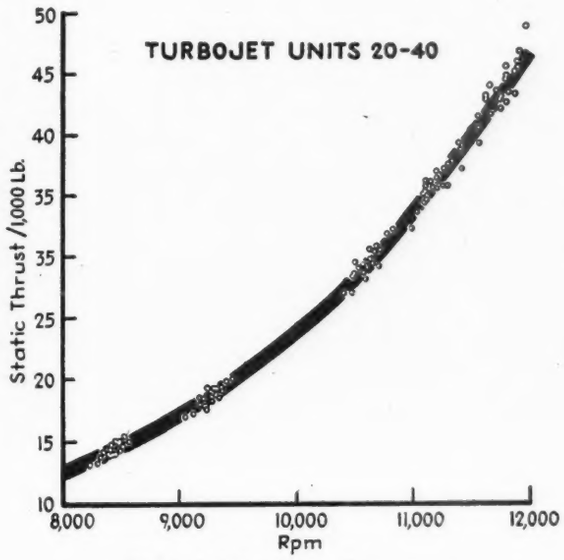


Chart of static thrust. Curve passes through 4,000 lb. at 11,500 rpm.

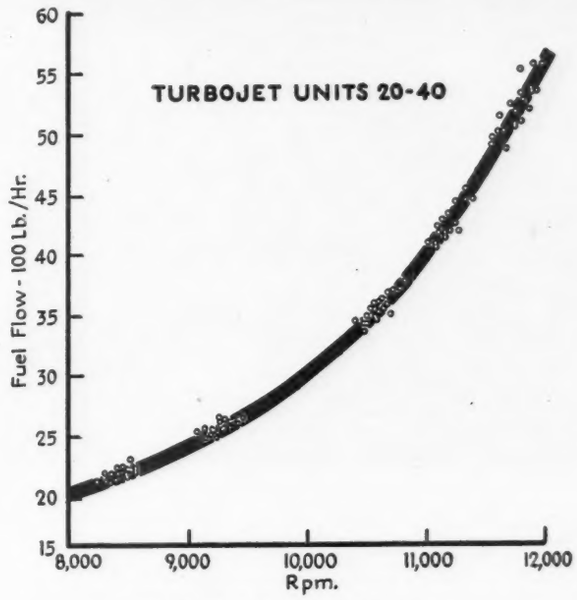


Chart of fuel flow. Curve passes through 4,740 lb./hr. at 11,500 rpm.

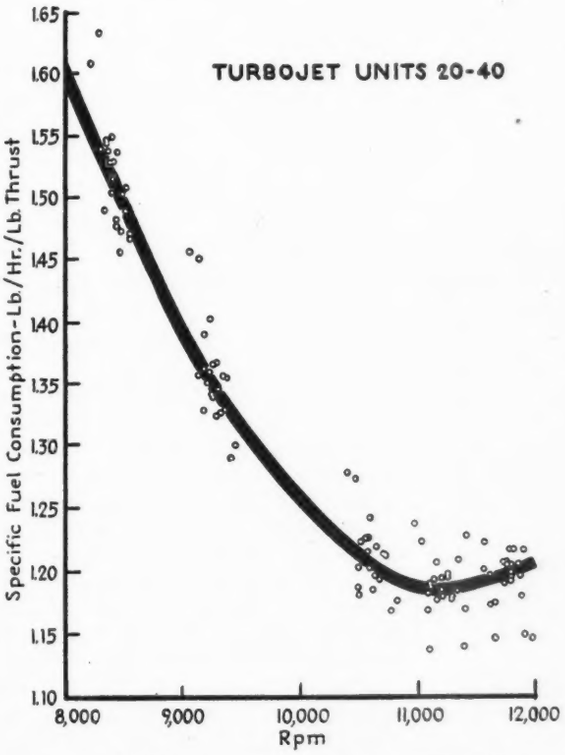


Chart of specific fuel consumption. Curve passes through 1.185 at 11,500 rpm.

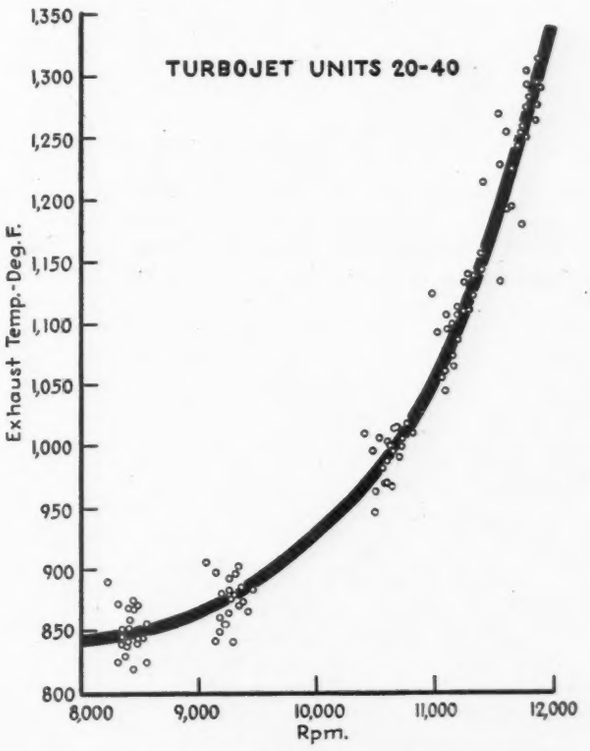
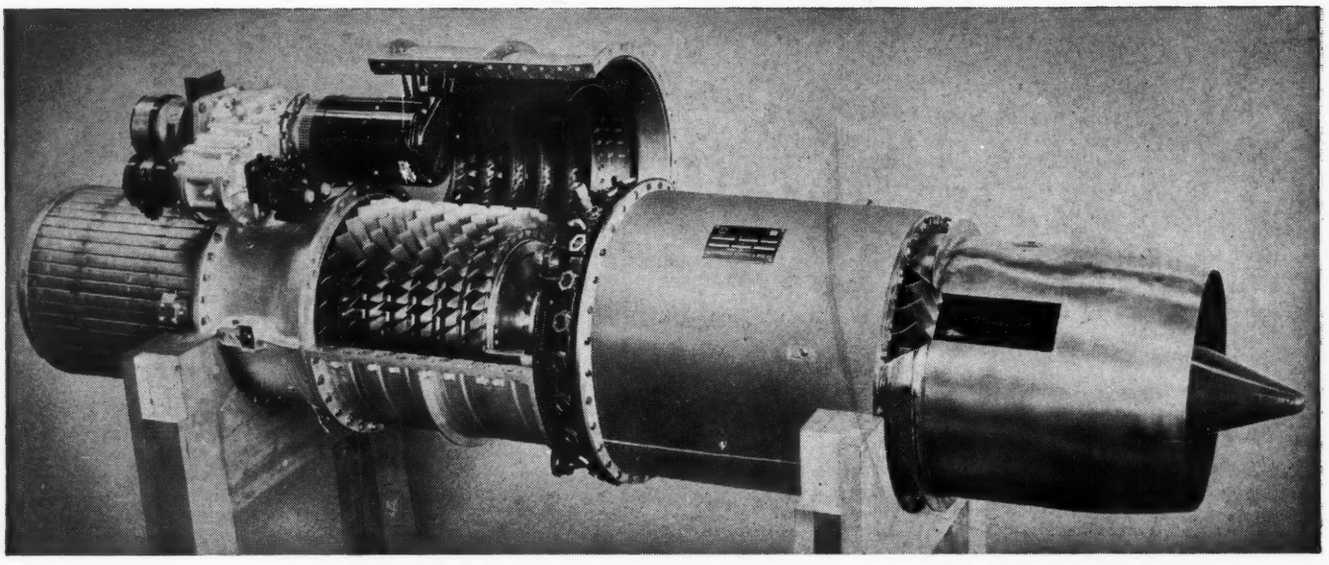


Chart of exhaust temperature. Curve passes thraugh 1,170 deg. F. at 11,500 rpm.



DESIGN ANALYSIS OF

WESTINGHOUSE 19-B YANKEE TURBOJET

By JOHN FOSTER, JR., *Managing Editor, "Aviation"*

First all-American designed—and first American axial flow—gas turbine power plant presented in complete detail as the 18th in Aviation's series of superlative analyses.

ORDERED BY THE NAVY the day after Pearl Harbor, the first All-American designed gas turbine jet propulsion engine was researched, designed, built and tested by Westinghouse Electric Corp. in just 16 mo.

Under Navy instructions the small group of engineers from the Westinghouse Steam Division made no contacts with any other group engaged in jet work. Principal results of these instructions were twofold: They produced the first American axial flow jet engine, and brought forth the most powerful engine in the world for its size—the 19-B Yankee. Later engines developed from the 19-A and B, which are still held under military security, may be assumed to produce even greater thrust.

One of the prime design requirements —small frontal area—made it natural to select the axial flow type compressor. Aside from the aerodynamic need, however, is the fact that a greater mass of air can be moved through the engine. In the 19-B, for example, the air takes less than .02 sec. to pass from the intake, through the compressor, into the combustion chamber, through the turbine nozzle and turbine and out through the exhaust cone.

On the 19-B the annular aluminum oil cooler is bolted by a flange to the leading edge of the intake casting-front bearing support. Thus the oil can be cooled even when the aircraft is stationary on the ground, but no aerodynamic sacrifice is made. Two types of coolers have been provided to care for varied installations, one 24 in. long being built up of rectangular cross section tubes, connected in series through cored flanges, and one 9⅜ in. long made up of spiral rectangular cross section tubes. This latter type has been made standard.

The front or No. 1 bearing support (corresponding to the intake casting of the Junkers Jumo 004 engine analyzed in Nov. Aviation, page 115) is an aluminum casting comprising an outer ring with fore and aft flanges, connected to the bearing housing by four faired struts. These struts are constructed to house the accessory drive shaft, oil passages—both inlet and scavenge—for the main and bevel gear bearings, and air vent holes measuring compressor inlet pressure for the altitude compensator. A small spinner-

type cap, quickly detachable by removing one screw, gives access to the accessory takeoff drive bevel gears without further disassembly.

On the 19-A engine all accessories were housed within a fairing around the leading edge of the bearing housing, similar to the installation of gasoline starting engines on the Jumo 004 and BMW 003 engines. On the B engines, however, the accessories are attached to a gear box fastened to a mounting face on the outside of the bearing support casting.

The front bearing itself is a babbitt-lined sleeve split along the horizontal centerline and grooved for oil passage. Sealing is effected by a combination pumping and labyrinth seal which bolts to the aft face of the bearing housing.

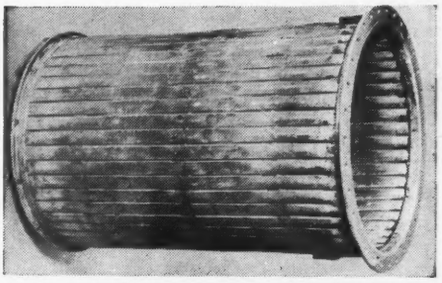
The 55 inlet guide vanes are of rolled steel held by two steel band shroud rings. Both roots and tips of the guide vanes are set in slots in the shrouds and welded in place. The outer shroud ring has four equidistant notches on the trailing edge, into which fit lugs that are screwed to the aft face of the casting to hold the ring in place. The inner ring is held in place by four safety-wired screws extending out through the inner ring of the casting.

Spindle of the 6-stage compressor, including shaft at the inlet end and coupling flange at the discharge end, is machined from a single aluminum forging, with each disk having a double convex cross section. Diameters of the disks range from 9.1 in. at stage 1 to 12.85 in. at the final stage.

Compressor blades are machined steel alloy with bulb-type roots. They are held in place in the milled disk slots by wire locking keys which are turned up into the grooved sides of the blade root. Profiles of the blades are based on a straight line-circular arc formula, giving a foil very similar to a laminar flow design. In addition to the aerodynamic considerations, use of this airfoil has been found advantageous in that it is easy—and thus inexpensive—to machine.

Though having the same foil, blades in the first compression stage have greater chord than do the succeeding stages, all of which are identical except for blade length. Centrifugal stresses in the first stage at the 19-B's maximum of 18,000 rpm. reach 30,000 psi., or some 50,000 G's.

The cast aluminum compressor casing is made in two halves which bolt together via axial flanges. In addition to the flanges at either end for attaching to the front bearing support and mounting unit, respectively, the casing is reinforced by a circumferential rib, and two axial ribs spaced at 90 deg. from the mating flanges of the halves.



Westinghouse 19-B Yankee axial flow turbojet oil cooler is attached to intake end of front bearing support-intake casting, thus assuring cool oil even when craft is stationary, and reducing frontal area.

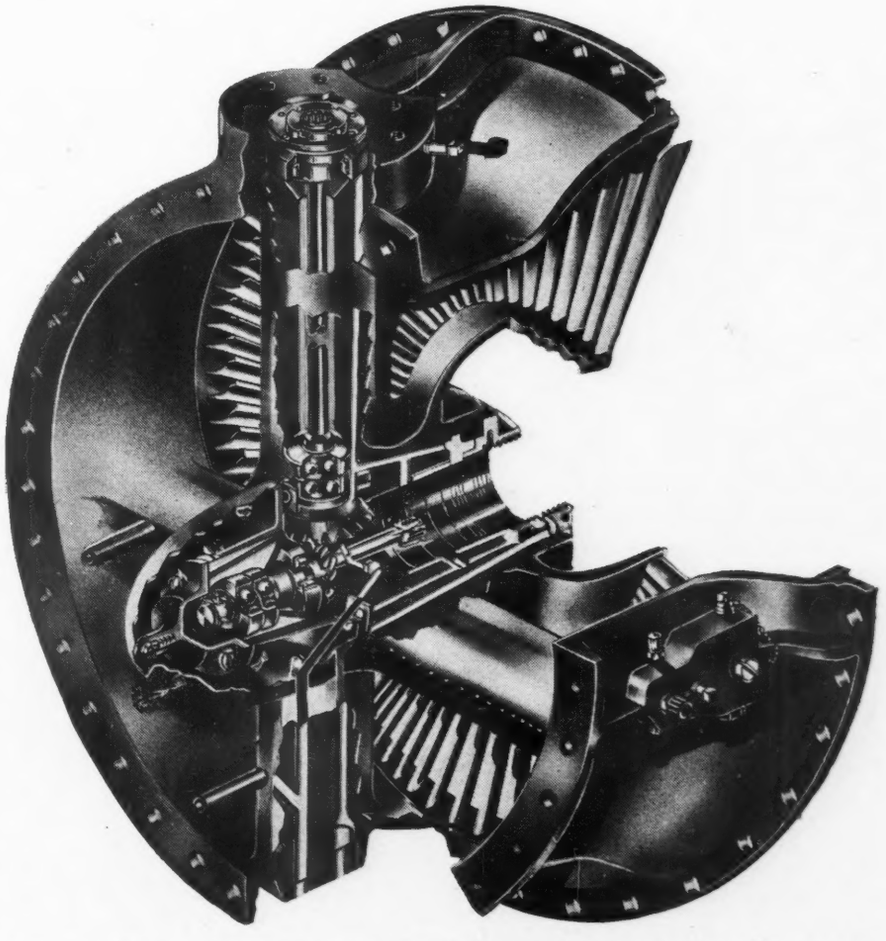
The inside of the casing has six machined grooves, five to take stator blade shroud rings, one for straightener vanes. In most cases the steel stator blades are cast, though some are rolled. The blade ends go through slots in the stainless steel shroud rings and are gas welded in place. Sealing rings, also of stainless steel, are formed by flanges which are welded to both edges of the inner shroud rings. The complete stator blade units are held in place by retaining screws at the base of the mating flanges.

Straightening vane assembly consists of three rows of vanes of NACA 6512 section, with construction like that of the stator assemblies, except for the sealing rings. The three-row design has been found most satisfactory, not only for skimming off boundary layer air, but for keeping up compressor efficiency and preventing choking.

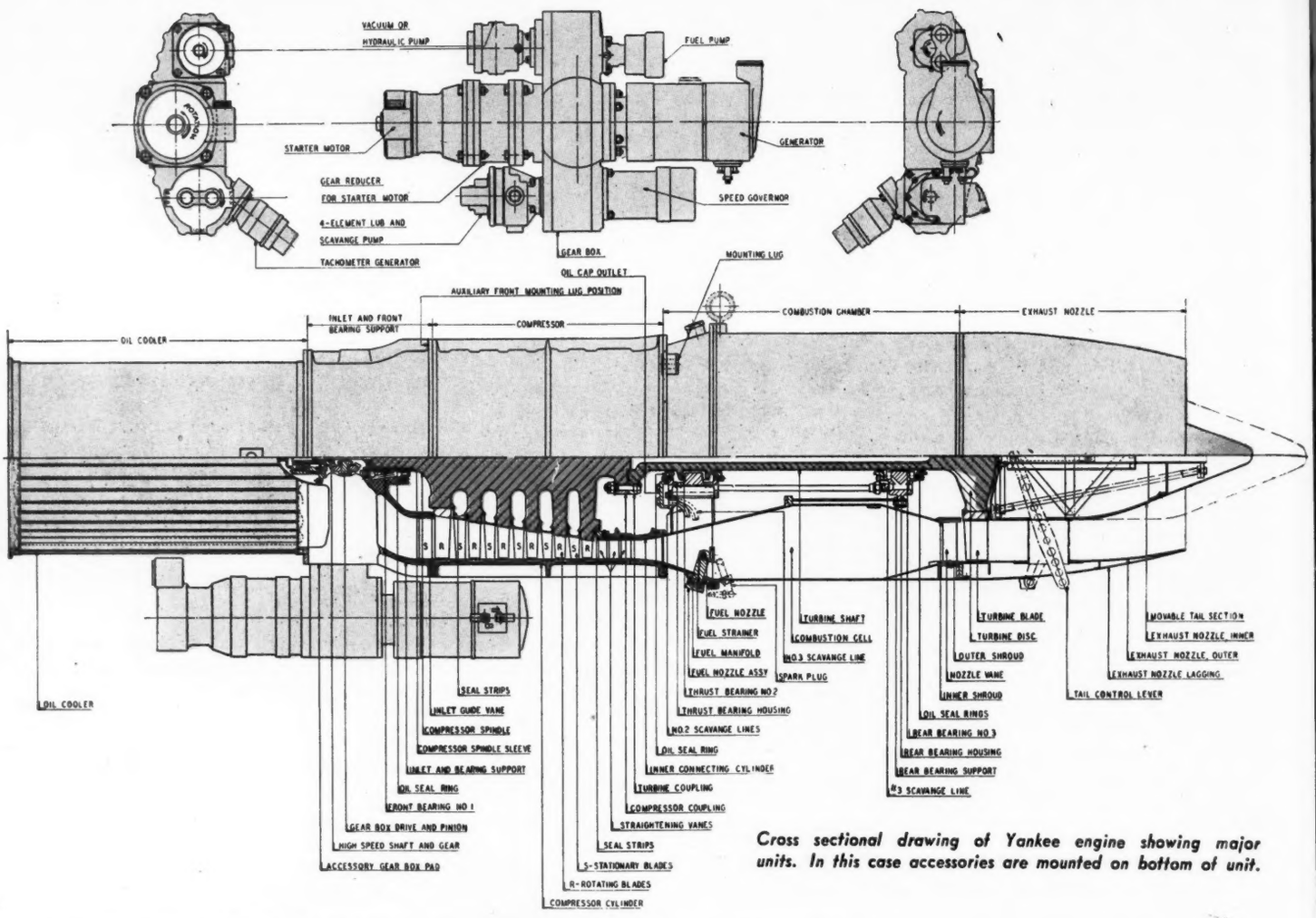
Pressure rise across each set of rotor and stator blades is equal, the total compression being just over 3:1.

Backbone of the 19-B is the fuel manifold and thrust (No. 2) bearing support, a builtup stainless steel unit consisting of three concentric rings tied together by eight hollow streamlined struts.

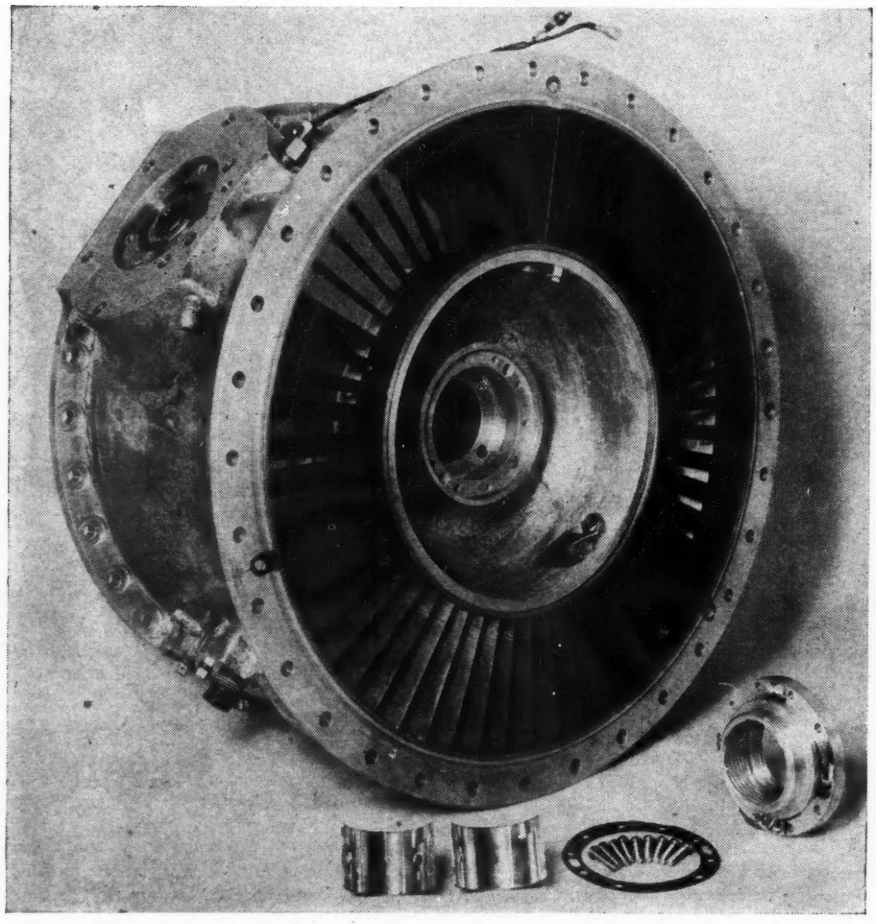
The outer single-walled 5-in. long ring has two welded flanges, that on the intake end supporting the compressor casing, that on the exhaust supporting the combustion chamber.



Cutaway sketch by R. W. Hibbs of 19-B front bearing support-intake casting showing bevel gears and accessory drive shaft extending up through fairing. Design of this turbojet permits locating accessories at top, on either side, or bottom, thus giving greater installation versatility.



Cross sectional drawing of Yankee engine showing major units. In this case accessories are mounted on bottom of unit.



Rear view of front bearing support with accessory case mounting face seen at upper left and showing method of installing inlet guide vanes. Front bearing is shown disassembled at lower right.

Welded to the front flange of this outer ring are the four engine mount lugs, $2\frac{13}{16}$ in. aft of cg. When installation permits use of all four lugs, the engine mount system will withstand all flight loads for the power plant itself, but not those imposed by deflections of the airframe. A preferable mounting system calls for use of the two top lugs and use of the auxiliary compressor flange for stabilizing in a vertical plane.

Middle of the three rings serves to split the air to streamline its flow into the combustion chamber as well as to function as the fuel manifold ring and support for the burner basket. The 24 fuel nozzles, of 9.5 to 12.5 gpm. capacity, are installed on the machined aft face of this ring. In some installations the spray angle is set at 45 deg., in most others it is 80 deg. In early installations each of the nozzles was protected by 80-mesh screen strainer, but this has since been changed to 120 mesh.

The inner ring, which converges toward the rear, extends 6 in. into the combustion chamber and, for the most

part, is single-walled. The thrust bearing support is welded to the inner ring, forming a double wall at the support. At the forward end of the ring there is an axial flange, to the inside of which are welded 18 anchor nuts for securing the inner connecting cylinder. At the rear end of the ring is a flange drilled to take 16 tap bolts for securing the rear (No. 3) bearing support.

Extending between inner and outer rings along the aft face is a 6 x 6 mesh per sq. in., 53% open area screen which creates turbulence and mixing of the air flow to the combustion chamber.

Seven of the eight struts connecting the rings provide passages as follows, reading in clockwise direction from the intake end:

Struts 1, 2, and 8—Leading edge drilled to mount thermocouple for measuring compressor outlet temperature.

Strut 3—Passages for leads of rear bearing oil outlet thermocouple.

Strut 4—Inlet oil line to thrust (No. 2) and rear (No. 3) bearings.

Strut 5—Two oil return lines from Nos. 2 and 3 bearings.

Strut 6—Passage providing for leads of thrust bearing outlet thermocouple.

Flanged to the fuel manifold-bearing assembly is the annular combustion chamber, a built-up, welded cylinder comprised largely of normalized stainless steel.

Complete details of the combustion chamber may not yet be revealed, but it can be said to include a perforated

General Specifications

Performance

Thrust, static sea level, 1,500 deg. turb. inlet temp.	1,365 lb.
Thrust, 500 mph., 1,500 deg. turb. inlet temp.	1,125 lb.
Air flow, static sea level max.	28 lb./sec.
Air flow, 500 mph. max.	38 lb./sec.
Temperature at turb. nozzle, max.	1,500 deg.
Temperature at turb. nozzle, normal.	1,200 deg.

Dimensions

Length, tail cone out, with oil cooler.	104 15/32 in.
Length, tail cone out, without oil cooler	80 15/32 in.
Diameter, basic	19 in.
Diameter, max.	20 3/4 in.
CG., forward of mounting lugs	2 in.

Weights

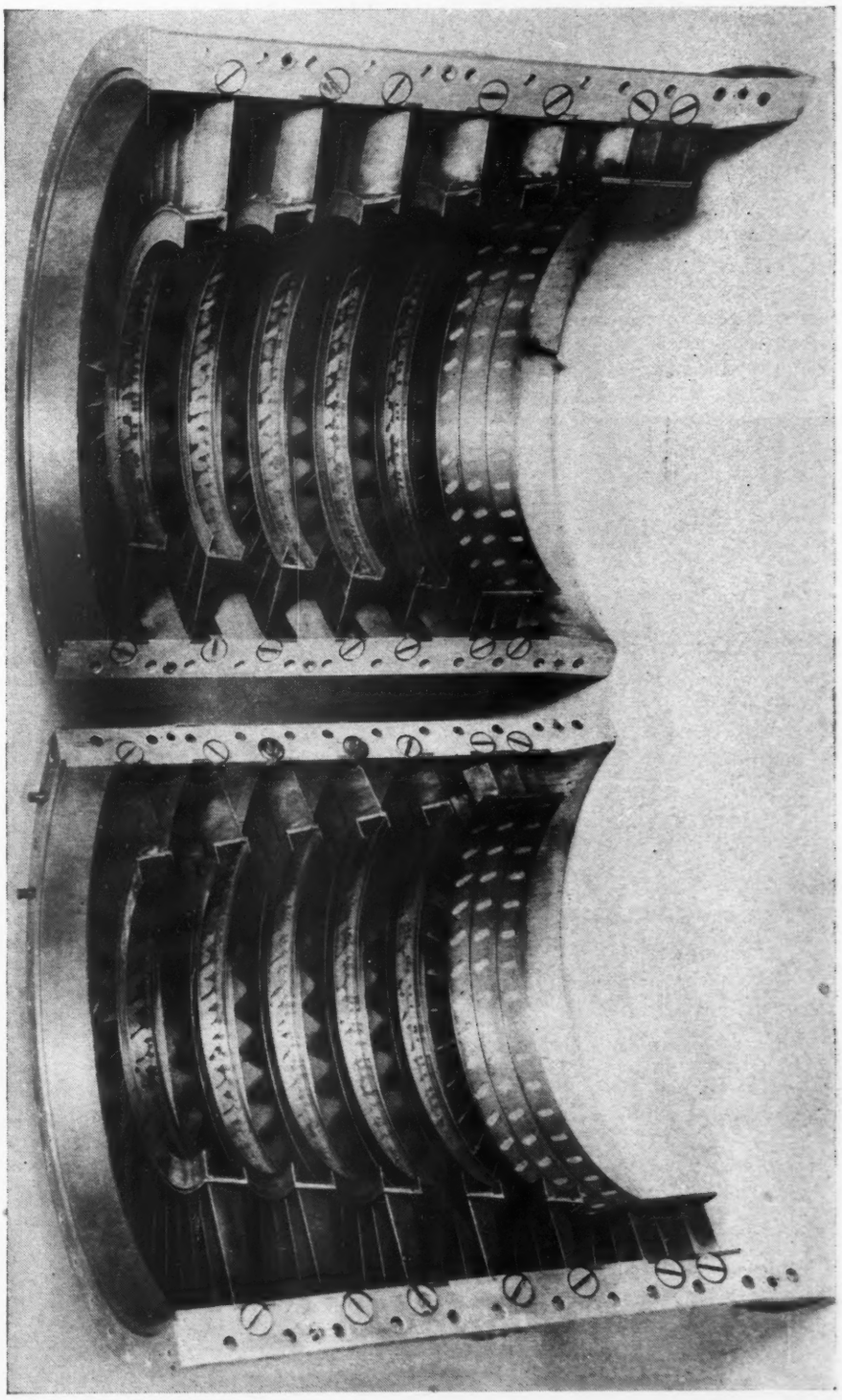
Dry weight, power plant	765 lb.
Oil cooler	20 lb.
Generator	35 lb.
Hydraulic or vacuum pump	6 lb.
Total dry weight	826 lb.
Oil (3 gal. min.)	21 lb.
Total installed weight	847 lb.

Clearances

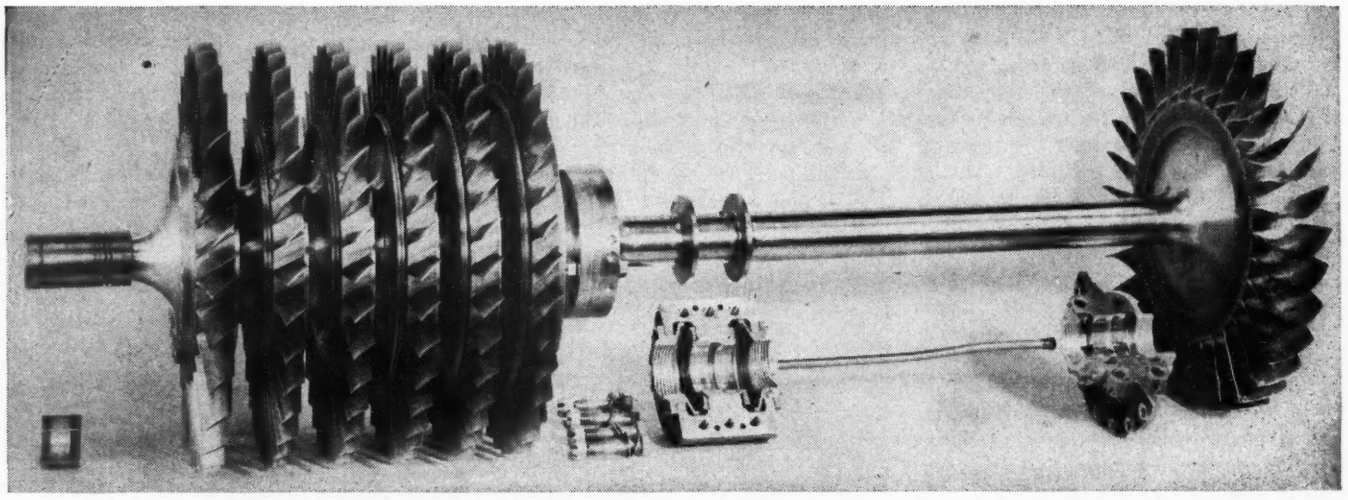
Bearings	
No. 1, radial	.005 in.
No. 2, axial, thrust face	.000 in.
No. 2, axial, unloaded face	.008 in.
radial	.005 in.
No. 3, radial	.005 in.
All bearing seals	.008 in.
Compressor	
Axial between rotor and stator blades	3/32 in.
Axial between inlet guide vane and first compressor stage	1/8 in.
Radial between rotor blade tips and casing	.030
Radial between stator shroud seal and rotor land	.030
Radial between straightener vane seal strips and rotor land	.020
Turbine	
Axial between nozzle inner shroud ring turb. disk	1/4
Axial between turb. disk and tail cone assembly	1/4
Radial, blade tips and exhaust cone shell	.0625
Turbine, nozzle vanes	
Loose fit, cold, .010 in. clearance in shroud ring slots	1/32 in. end play

Normal Temperatures & Oil Pressures

	12,000 rpm.	18,000 rpm
Turbine inlet temperature	800—1,000 deg. F.	1,000—1,200
No. 1 bearing oil outlet	90—100 deg. F	110—140
No. 2 bearing oil outlet	135—165 deg. F	190—235
No. 3 bearing oil outlet	160—190 deg. F	185—215
Fuel pump discharge pressure	250—280 psi.	
Fuel mainfold pressure	30—35 psi.	
Oil pump discharge pressure	50—60 psi.	90—120

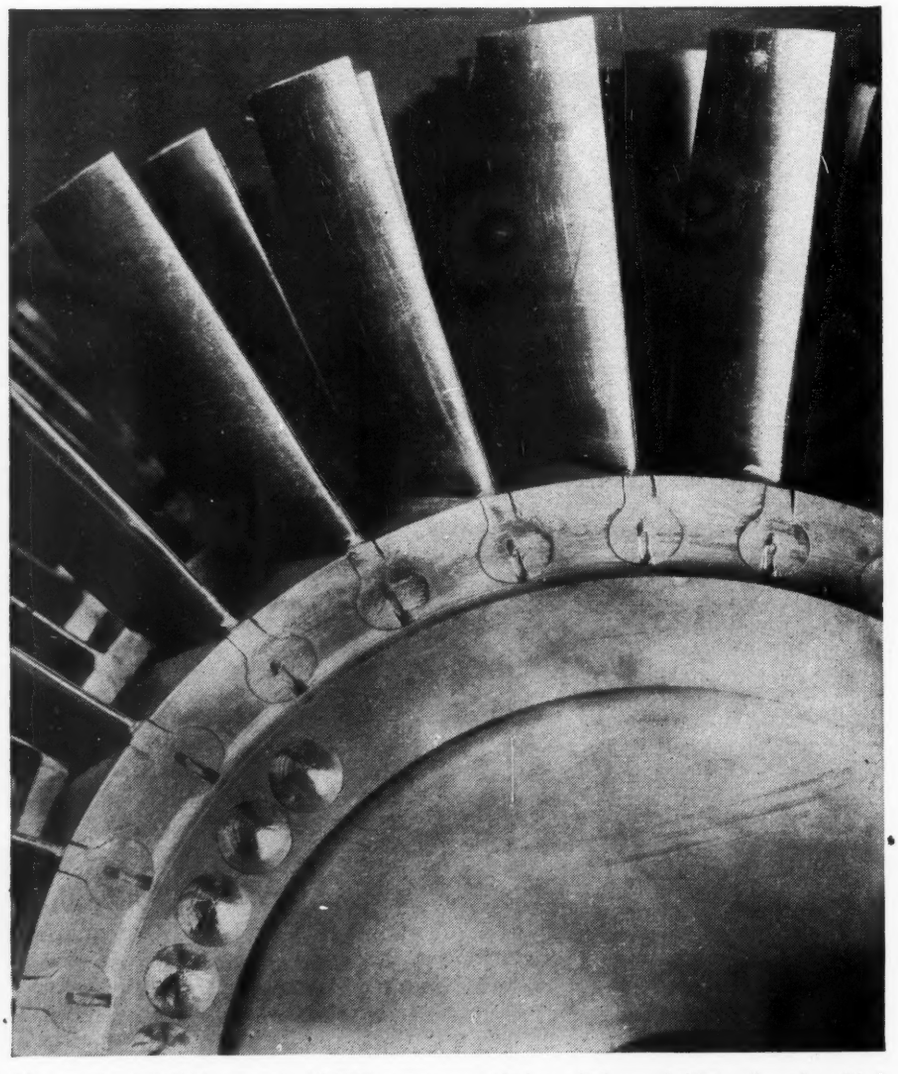


Top and bottom halves of compressor casing with stator blades installed. Both inner and outer stator shroud rings are stainless steel, with blades welded in place in slots. Sealing rings are welded to shroud rings.



Yankee compressor spindle is machined from single forging, as are turbine disk, shaft, thrust faces, and coupling flange. Front (No. 1) and turbine (No. 3) bearings are radial only; thrust (No. 2), takes both thrust and radial loads.

conical burner ring so designed that the turbulence created gives complete combustion at the high velocities developed in the 19-B. One feature is direction of a layer of cooling air along the inner surface of the casing shell so that temperatures of the casing do not exceed 400 deg. F.



Closeup shows bulb type roots of 19-B compressor blades, which are held in place in milled disk slots by wire locking keys turned up into grooved sides of blade root.

The turbine nozzle assembly is composed of 45 Vitallium nozzle vanes held loosely—to permit thermal expansion—in slots in concentric steel shroud rings, the whole unit fitting into the rear of the combustion chamber between the No. 3 bearing sleeve and the outer casing. The outer shroud ring is machined to fit below the chamber flange face, thus facilitating attachment of the exhaust nozzle. This shroud ring is held in place by four lugs, similar to those on the inlet guide vane assembly; the inner ring by six tap bolts, also similar to those on the inlet guides.

Turbine disk, shaft and coupling flange are machined from a single Cyclops 19-9-W-MO forging. The shaft coupling has a machined face with counterbored and chamfered female spigot for positive alignment, and is attached to the compressor by ten ½-in. fitted bolts. No universal joint effect has been found necessary in the coupling.

Aft of the coupling are two vertical thrust faces, finish machined and polished from an increased shaft o.d., for the thrust (No. 2) bearing. Just forward of the disk is the polished journal for the turbine (No. 3) bearing.

As on the compressor, the 32 turbine blades—K-43-B machine and hand finished forgings—have bulb roots fitting into milled slots in the disk, and are held in place by peening the shank of the root into chamfers at each end of the slots.

The thrust bearing—which also carries radial loads—is made up of a cast steel housing containing lube and scavenge oil connections and holding babbitt sleeves and babbitt-covered radial faces to take the axial thrust. The turbine bearing is a cast steel housing split

along the horizontal outerline with a babbitt-lining sleeve grooved for oil passage. This housing is drilled and cored for both lube and scavenge passages. Bearing seals of both thrust and turbine bearings are similar to those on No. 1 bearing.

Outer casing of the exhaust nozzle is stainless steel with a welded flange at the leading edge holding it to the aft combustion chamber by 32 bolts. Surrounding the casing at the turbine blade trailing edges is a welded 1-in. steel ring to give greater stiffness to the unit in an area where clearance between blade tips and the casing is approximately .0625 in.

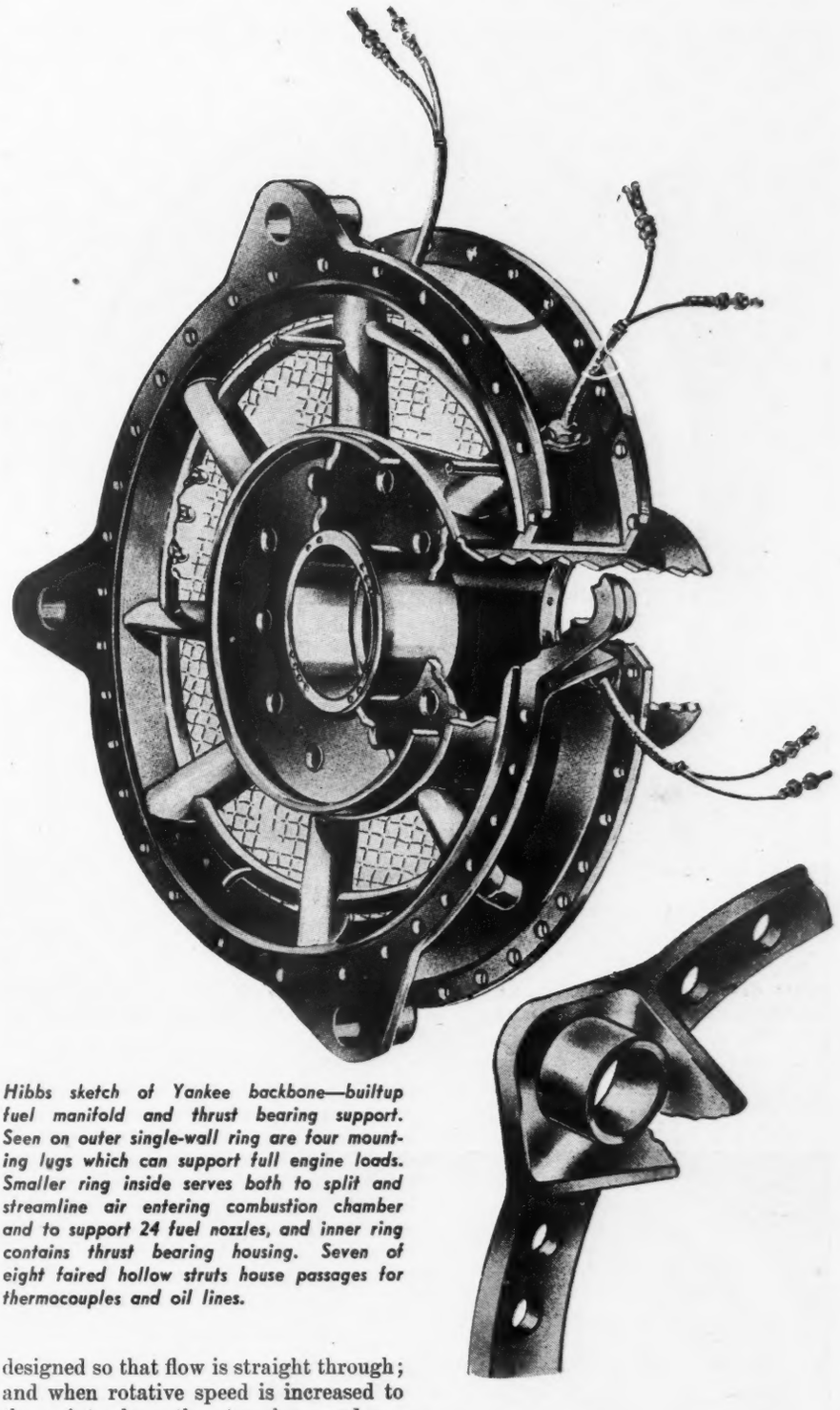
Inside the exhaust nozzle casing are four hollow streamlined struts supporting the movable tail cone, the motion being imparted through a pivot and linkage coming out through one of the struts to connect with an electric actuator installed on the combustion chamber casing.

The movable cone gives greater operating efficiency, especially where rapid acceleration is required. In the "cone in" position for starting and idling, the exhaust area is greatest, reducing pressure immediately aft of the turbine and making available the full pressure drop available to the turbine. In the "cone out" position the outlet area of the exhaust nozzle is reduced and back pressure on the turbine increased, thus reducing available energy to the turbine so that higher temperatures and more fuel are required to maintain rotative speed. The additional energy thus delivered to the jet is realized in the form of an increase in velocity of the flow through the reduced nozzle area.

Accessories for the 19-B include: Electric starter, generator, fuel pump, oil pump, governor, vacuum or hydraulic pump, and tachometer generator, all mounted on an aluminum casting gear box containing a train of twelve gears.

To give greater leeway in 19-B installations, the gear box can be placed on top, bottom, or either side of the engine simply by attaching the front bearing support so that the drive shaft from the bevel gears points in the desired direction.

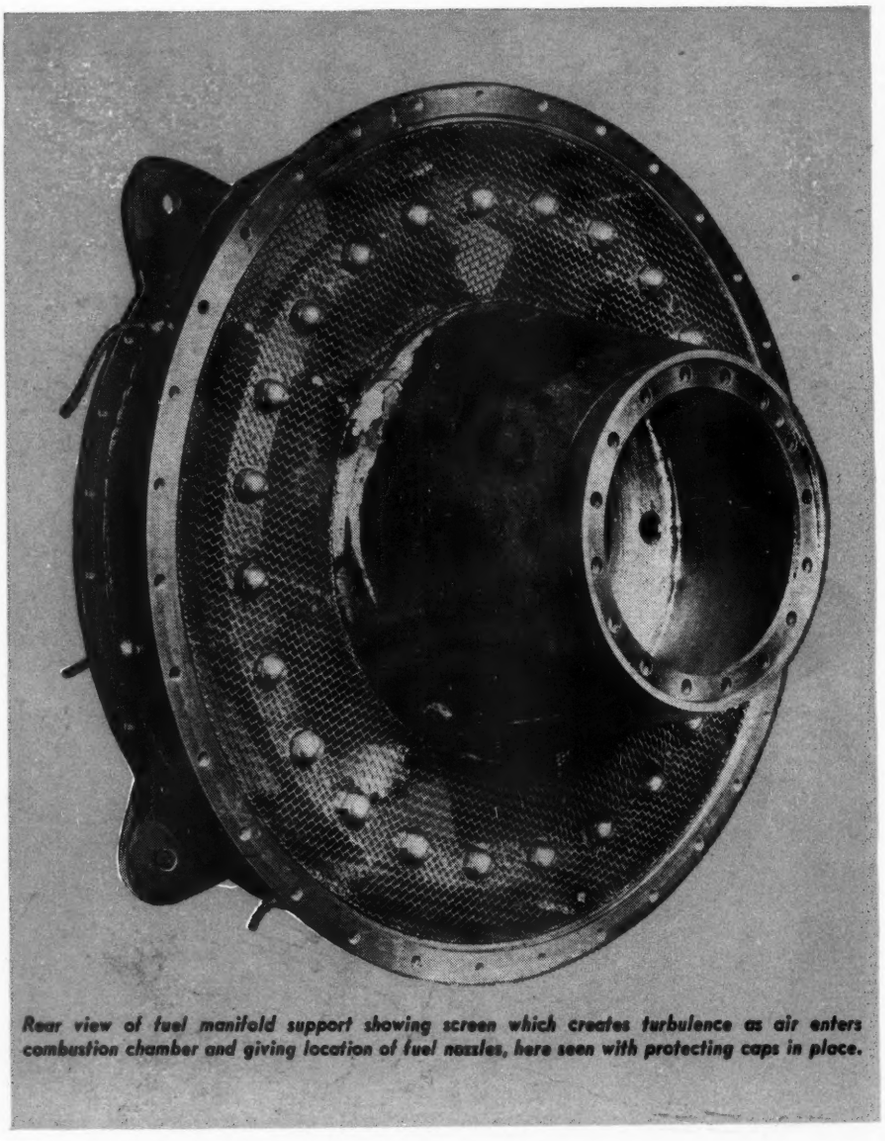
The governor, designed to protect against overspeed, is of mechanical flyweight type. As it rotates at high speeds, centrifugal force on the weights increases and exerts an increasing force on the governor spring through toes on the weights. When this force overcomes the force of the spring, the governor stem moves up till the force of the weights equals that of the spring. Motion of the stem is used to control fuel flow through a balanced relay valve



Hibbs sketch of Yankee backbone—builtup fuel manifold and thrust bearing support. Seen on outer single-wall ring are four mounting lugs which can support full engine loads. Smaller ring inside serves both to split and streamline air entering combustion chamber and to support 24 fuel nozzles, and inner ring contains thrust bearing housing. Seven of eight faired hollow struts house passages for thermocouples and oil lines.

designed so that flow is straight through; and when rotative speed is increased to the point where the stem is moved up, the valve is forced into the fuel path, restricting flow to the burner. As the valve is forced into the fuel path, pressure is raised before the valve, this increase in pressure opening the relief valve to by-pass fuel not required. Both ends of the relay valve have spiral washout grooves to reduce pressure wedging and to clear out dirt that might cause the valve to stick. To prevent rapid closing of the valve, with consequent governor instability, an orifice is installed in the leakoff line from the bottom of the relay, giving a dashpot action which prevents the valve from moving faster than the engine can respond.

Pressure lubrication is provided by a four-element pump, one element for delivering oil to the bearings, three for scavenging. The pump draws oil from the tank, pumps it through the filter, relief valve, cooler, bearings and accessory gear case. A check valve is provided between the scavenge pump and tank so the latter can, if necessary, be



Rear view of fuel manifold support showing screen which creates turbulence as air enters combustion chamber and giving location of fuel nozzles, here seen with protecting caps in place.

installed above the engine centerline.

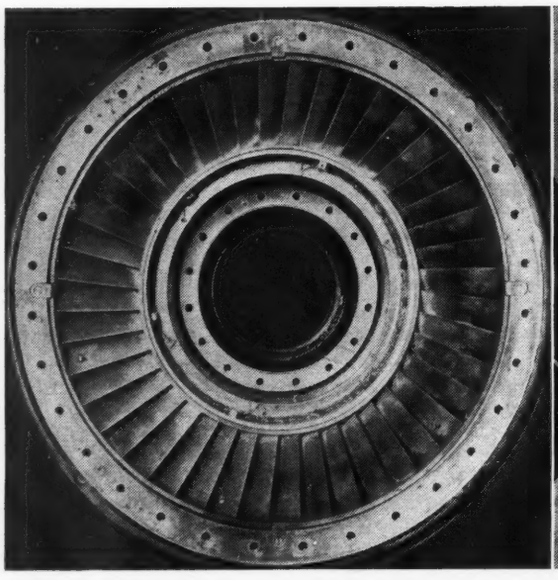
Lube oil is fed to the front bearing support through a 7/32-in. orifice and is also distributed via drilled passages to the accessory spiral bevel gears and the high speed horizontal bearing assembly. Oil enters the front bearing through a 1/4-in. hole, is sprayed on the bevel gears by a nozzle with a 3/32-in. orifice, and enters the high speed bearing assembly through a passage with a .021-in. orifice.

Accessory drive shaft bearings are lubricated by oil leakage from the accessory drive shaft, as oil from any of the four inlets in the front bearing support and gear box lubricates the bearings as it flows to scavenge points.

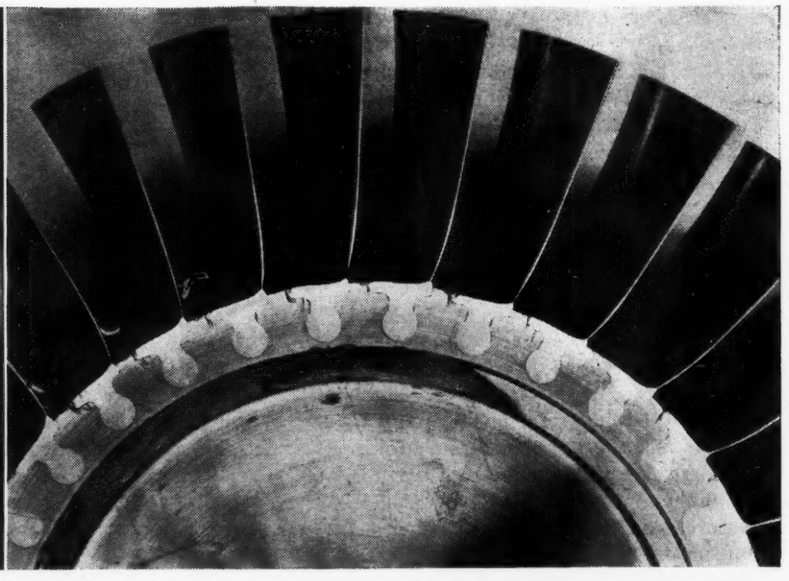
A line to the accessory gear box has a 7/32-in. orifice supplying high pressure oil to a fitting in the front bearing support, from where an internal passage delivers it to a spray nozzle.

Thrust and turbine bearing oil is piped to fittings on the fuel manifold support assembly, where it goes through internal piping to the forward face of the bearing support adjacent to two holes in the thrust bearing housing. A cored aluminum cap, bolted to both support and housing, forms a passage across the joint of those two units and feeds oil through two holes—one into the thrust bearing, the other, via a 3/8-in. tube, to the turbine bearing housing. The internal piping proportions the oil between thrust and turbine bearings.

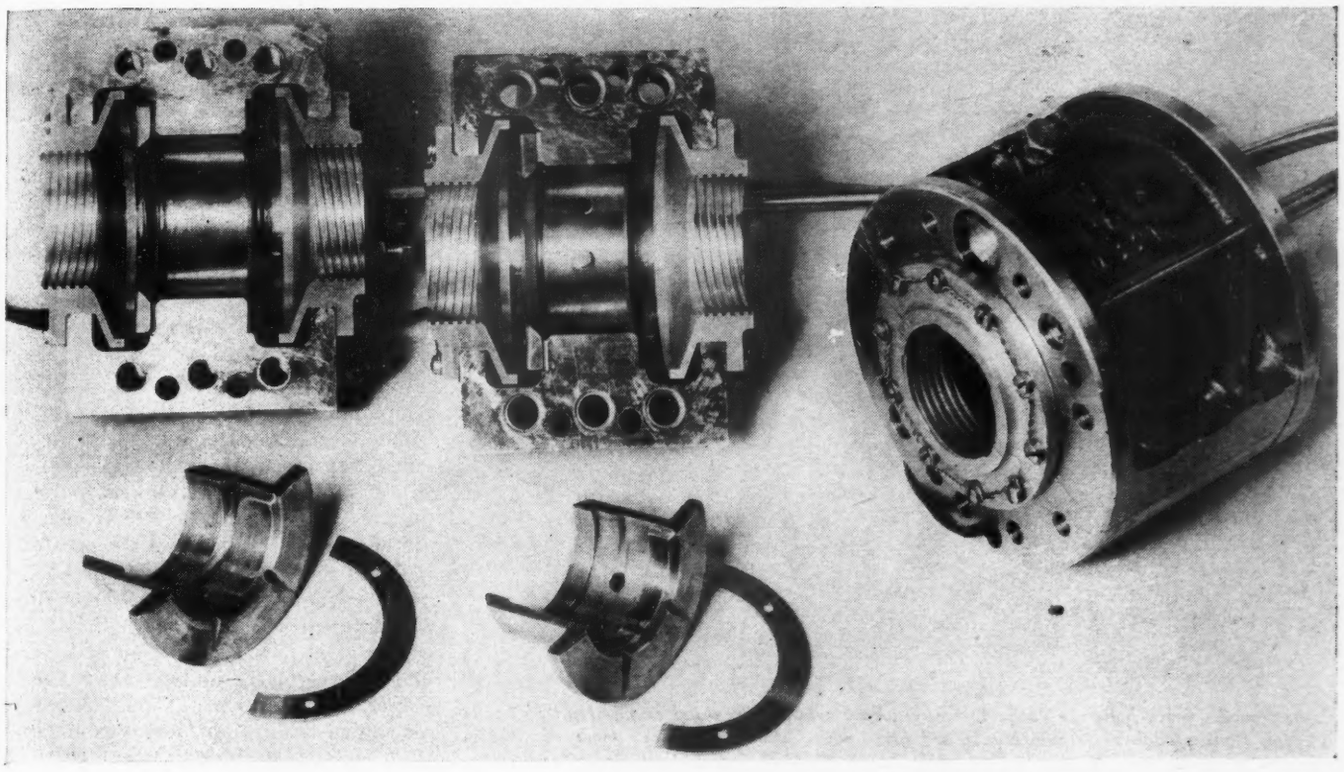
Pilot controls are reduced by having the gear-type fuel pump output delivered to a barometric relief valve, sensitive to both total air pressure and fuel pressure, to regulate the fuel pressure



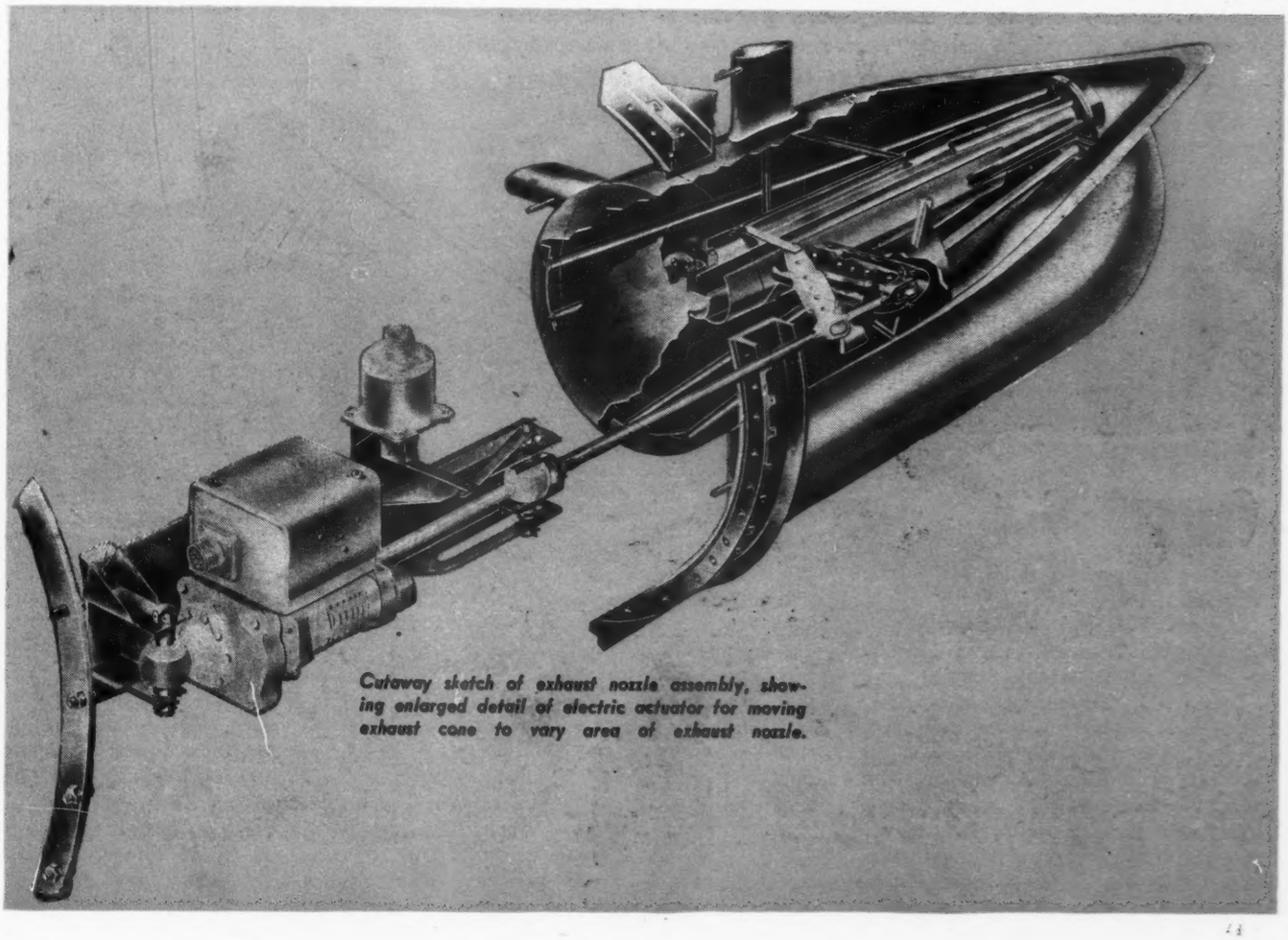
Turbine nozzle assembly showing lugs which hold outer shroud ring in place and tap bolts securing inner shroud ring.



Machined, hand finished forged turbine blades have bulb type roots fitting into milled slots, and are secured by peening shank of roots into chamfers at each end of slots.



Exploded view at left shows components of thrust bearing, which is shown assembled at right.



Cutaway sketch of exhaust nozzle assembly, showing enlarged detail of electric actuator for moving exhaust cone to vary area of exhaust nozzle.

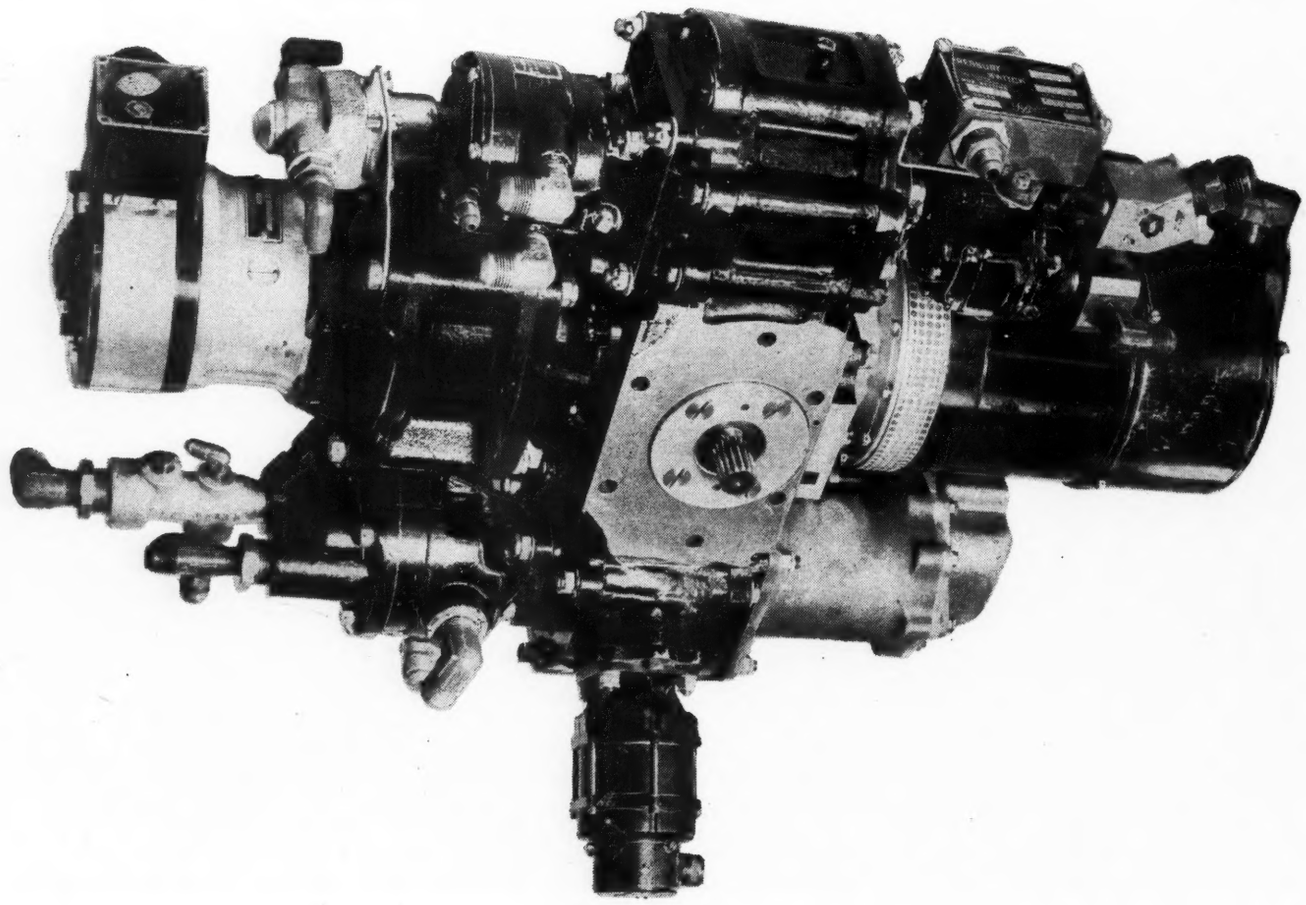
Exhaust nozzle, which bolts via flange to fuel manifold support. Welded ring just aft of flange is along trailing edge of turbine blades and gives added stiffness to cone. Inner ring, which supports movable cone, is attached to outer nozzle shell by four hollow streamlined struts.

before throttle and governor. From the barometric the fuel goes through the governor and throttle, then through a dump valve, into the manifold and through the nozzles into the combustion chamber.

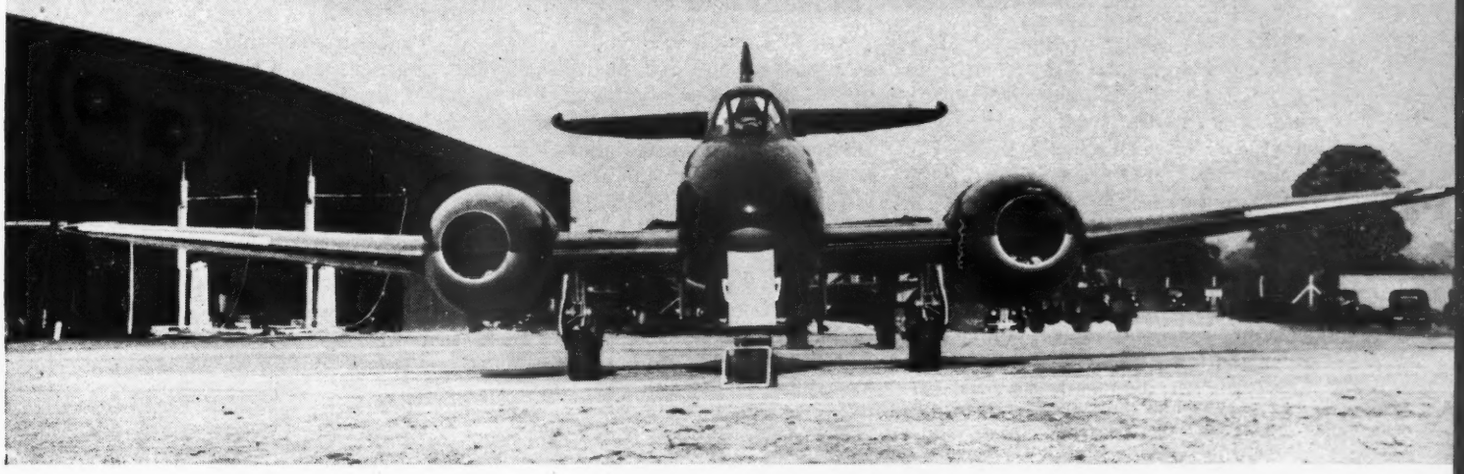
The piston in the dump valve is spring loaded open and is closed by admitting fuel outlet pressure to the opposite side of the piston. Thus when fuel to the pump is cut off, the valve opens and fuel is scavenged from the manifold to prevent fire in the combustion chamber when the engine is shut down.

Since the engineers charged with developing the 19-B had to work entirely without reference to other American turbojet projects they were, to put it mildly, on a spot. The resulting powerplant is a tribute to their maintenance of the courage of their convictions for, with less than half the weight and about half the length and diameter, the engine delivers nearly 70% as much thrust as enemy axial flow types which had been under development at least three years longer. The Yankee might well be termed an engine "radical in aerodynamic design, conservative in mechanical design."

Yankee accessories seen from below, with connection which fits on splined drive shaft shown in middle of gear box mounting face. Accessories on front face, top to bottom, include: Hydraulic or vacuum pump, starter motor and lubricating-scavenger pump; on side face, tachometer generator; and on rear face fuel pump, generator and governor.



THE ENGINEERING BEHIND THAT 606-MPH. METEOR



Front view of record-shattering jet-propelled Gloster Meteor.

By A. H. NARRACOTT, *Air Correspondent, London "Times"*

Traveling at almost 900 ft. per second, the Gloster Meteor recently bettered previous speed records by over 135 mph. Disclosed here is history of research and development of the craft and of the Rolls Royce Derwent V jet engines which power it.

THE WORLD AIRSPEED RECORD of 469.2 mph., established in Germany in 1939, was broken on Nov. 7 at Herne Bay, England, by Group Capt. H. J. Wilson, A.F.C., of the RAF, flying a Gloster Meteor IV jet-propelled aircraft, powered by two Rolls-Royce Derwent V engines. He established a new speed mark by covering four laps over a 3-km. course with an average speed of 606 mph. His lap times were 604, 608, 602, and 611 mph.

The craft, selected for Britain's attack on the speed standard, and the Rolls-Royce Derwent jet-propulsion engines with which it is powered, are respectively the indirect and direct outcome of the pioneering efforts of Air Commodore Frank Whittle, RAF, who designed and developed the first jet unit in Britain, even though the Derwent engine represents a great advance on the original Whittle unit.

Starting as early as 1928, Whittle obtained sufficient backing to form the firm of Power Jets, Ltd., since taken over by the British Government. First design was a single combustion chamber type, with single-stage turbine-operated compressor. Compression ratio aimed at was 4:1 using a 16½ dia. turbine wheel to operate compressor supplying 3,000 shp.

Testing of the first Whittle engine began in Apr. 1937, but various defects were discovered. Later, in Oct. 1938, the third type was damaged beyond repair by a turbine failure, but not before it had yielded information to enable the development work to proceed.

Flight testing started in 1939, and in the Summer the British Air Ministry placed a contract with the Gloster Aircraft Co. for the manufacture of an experimental aircraft which became known by its specification number of E28/39 and was the prototype of the Gloster Meteor twin-jet fighter.

The engines were installed in the E28/39 airframe for taxiing trials in Apr., 1941, and flight trials started the following month. In the first few efforts, the machine exceeded the then top speed of the Spitfire at all heights. Initially powered by the W-1 engine, which was rated at a static thrust of only 850 lb., the E28/39 was flown subsequently with a succession of engines supplied by Power Jets and Rolls-Royce, and it achieved a speed approaching 500 mph. before being grounded.

By arrangement between the British and United States Governments, one Whittle-type engine, built by British Thomson-Houston, a complete set of drawings, and a small team of Power Jets engineers, were flown to America in the Fall of 1941 and thus initiated the intensive development of the jet-propulsion gas turbine by General Electric at Lynn, Mass. What was known as the W2B engine became the prototype of the Rolls-Royce Welland engine which subsequently powered the Meteor Mark I in Britain. "Type 1," the engine made by General Electric in America, powered the Bell P-59 Airacomet. The Meteor I went into production with the Welland engine and was delivered to RAF Fighter Command squadrons in time to take a heavy toll of the V-1 flying bombs directed against Southeastern England from German bases on the continent.

It may be noted that although an RAF squadron equipped with Meteors was stationed in Holland during the closing stages of the war and made almost daily patrols, these flyers did not succeed in making contact with the jet-propelled Messerschmitt 262.

Meanwhile, development of the jet

engine went steadily ahead at the Rolls-Royce works in England, and the Derwent engine was produced. It now develops twice the power of its predecessor, the Welland, and in order to accommodate this engine, the nacelles of the Meteor have been made longer.

The Meteor is a single-seat fighter, a low-wing all-metal monoplane with a tricycle landing gear. Wing span is 43 ft., length 41 ft., height 13 ft., and wing area 374 sq. ft. The aircraft is constructed of six separate units: The fuselage nose; front fuselage with nose wheel; center section (embodying the center plane with the two undercarriage units and the two nacelles); two outer planes, with ailerons; and the rear fuselage, complete with tail portion and tail unit, consisting of the upper fin, upper and lower rudders, stabilizer, and elevators. The high stabilizer, necessitated by the jets from the propelling nozzles, splits the rudder in two. Trimming tabs are fitted on each elevator and to the lower portion of the rudder.

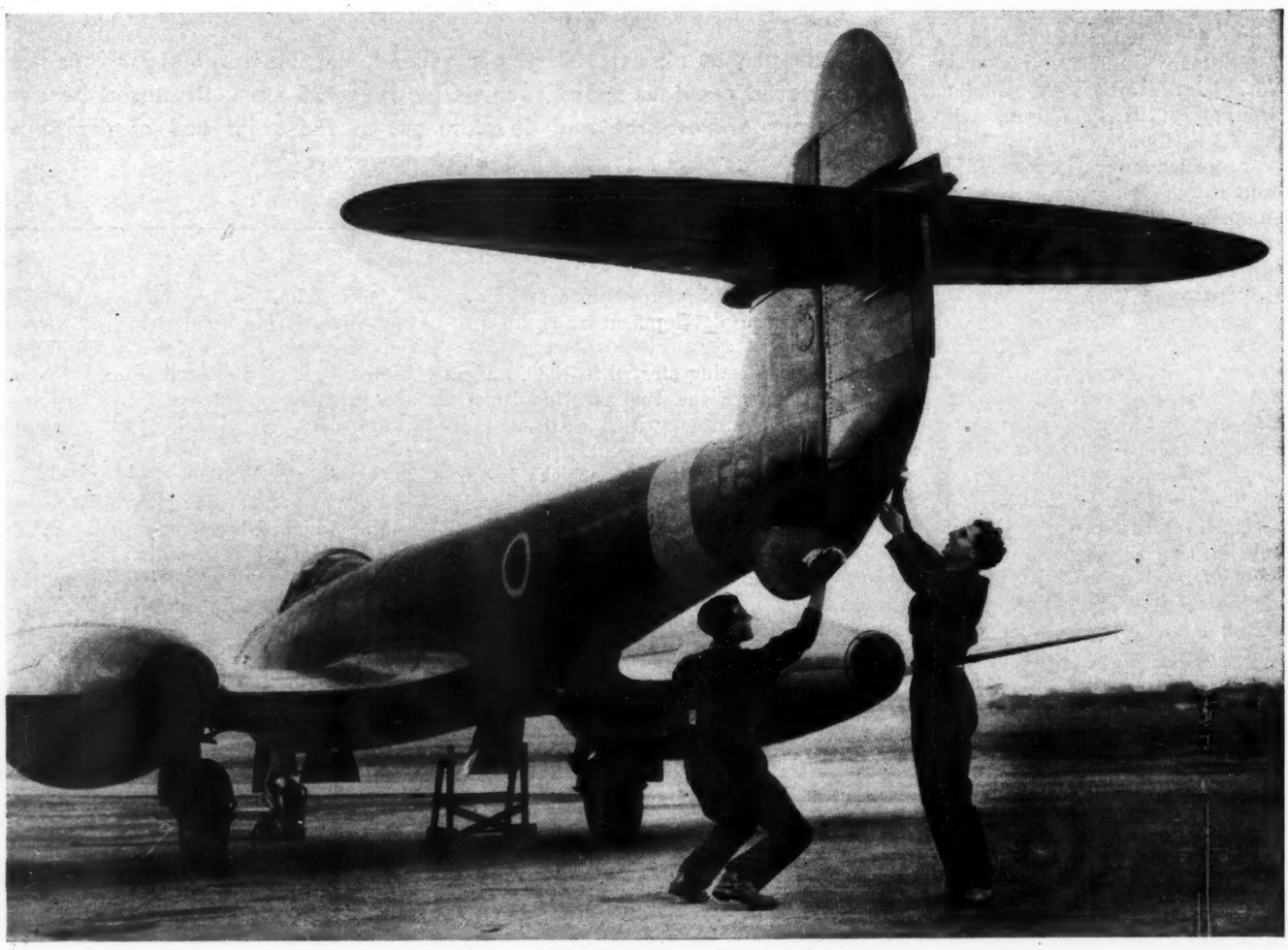
Front fuselage basis comprises two fore-and-aft vertical diaphragms and three solid bulkheads. The internal structure is sealed between the nose wheel bulkhead and the seat bulkhead to form a pressure cabin if required. The third, or front spar bulkhead, is bolted to a similar bulkhead in the center section. The center section and the rear fuselage are semimonocoque.

Two rearmost frames of the rear fuselage are extended upward to form posts for the lower fin and to give attachment points for the stabilizer and upper fin. Main wing is a two-spar stressed-skin structure. Center section spars are spaced by six major ribs interspaced with lighter skin ribs. Each engine nacelle has two main frames attached near the outer ends of the spars. The two undercarriage bays, upper and lower air brakes, and flaps are all between the nacelles and the center fuselage. The outer wings, joined to center section of both spars, have plate and lattice type ribs. Internally mass-balanced ailerons are all-metal structures with tabs. The outer wing tip is detachable, for production and replacement reasons. Components of the tail unit are of stressed-skin construction.

Hydraulically operated tricycle landing gear consists of two independent units retracting inboard and a nosewheel which retracts rearward, the wheel being housed between the rudder pedals.

Control stick has a hinged spade grip, and rudder pedals have parallel action. Trim tabs are operated by handwheels. Each engine is mounted between two center section ribs. The same type wide trunnion mountings are used for the Derwent or Welland engines, but the Wellands have a forward steadying attachment while the Derwent engines are steadied at the rear by a torsionally free diamond bracing. The generator (port nacelle), hydraulic pump (starboard nacelle), and vacuum pumps (both nacelles) are driven by gearboxes on the front spar in front of the engines.

The self-sealing fuel tank is divided by a transverse diaphragm; each compartment normally feeds one engine, but there is an interconnecting balance cock, normally closed. Feed to the burners is maintained by tank-mounted and engine-driven pumps. The oil system for each engine is self-contained. Engine-driven hydraulic pump operates the landing gear, flaps, and airbrakes, while an emergency hand pump oper-



Rear view of Meteor, showing high tail, so placed to avoid exhaust gases. Note that stabilizer divides rudder into two sections. (British Combine photo)

ates all services. The pneumatic system operates the gun-cocking gear and main wheel brakes; there is no nose wheel brake.

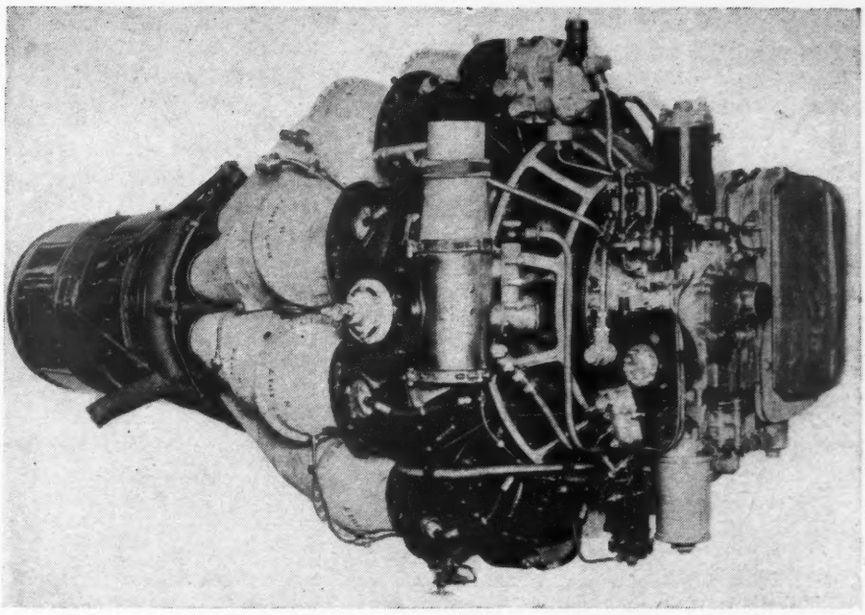
Electrical system is supplied by a 20v. 1,500w. generator on the port engine, charging two 12v. batteries. Remote control two-way radio is mounted in rear fuselage. Beam approach and IFF installation are also fitted.

The Derwent engine was a record breaker from the start. It was designed and the first engine tested within a period of three-and-a-half months, developing no less than 2,000 lb. thrust at 16,500 rpm. Rolls-Royce first investigated jet-propulsion in 1938, and in 1939 the first designs were made. In 1940 tests were made on various components, and in June, 1941, a plant was set up at Derby for compressor development. At the end of 1941, Rolls-Royce started manufacture of the Whittle-type engine in conjunction with Power Jets.

The first engine, known as the WR-1, was designed for experimental purposes, with low turbine blades stresses—a comparatively big engine for a given thrust. Its dia. was 54 in. and the design thrust was 2,000 lbs. It weighed only 1,100 lb., and the first engine ran for 35 hr. Two were built, but trouble was experienced with combustion, so extensive development work on combustion chambers and turbine blades was carried out. The restricting factor was construction of the turbine blades, due to limitations of temperature and rpm., but so much progress was made that Rolls-Royce was asked to take over the development and manufacture of the Whittle units.

Meanwhile, a Vickers Wellington aircraft was turned into a flying test plane, with the W2B/23 Whittle engine in the tail, in place of the gun turret. The instrument panel was mounted forward, with remote control to the engine, and in this way 25 hr. of flying was carried out, the first engine giving 1,250 lb. thrust. A second Wellington was adapted for high altitude work at 35,000 ft., and is still flying. The first engine passed its 100-hr. test in Apr., 1943. It was of 43 in. dia. and gave a thrust of 1,700 lb. for a weight of 850 lb. It was named the Welland because it was the first of the Rolls-Royce "River" class of jet-propulsion engines. Deliveries of the Welland to the RAF began in May, 1944, when this engine also passed its 500-hr. test and went into service with 180 hr. between overhauls.

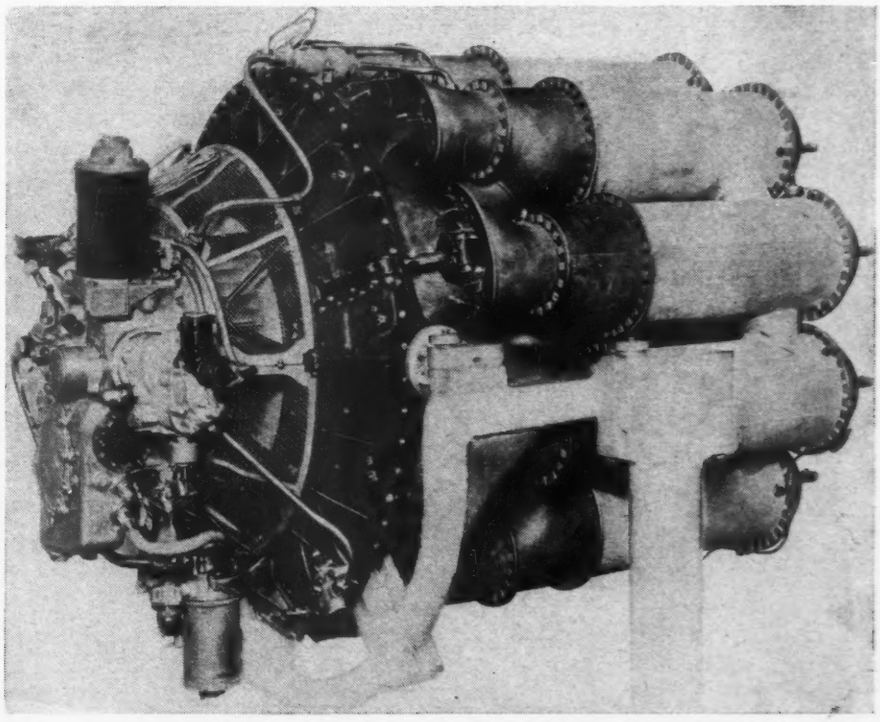
In Apr., 1943, was begun the design of a new jet engine with the same dia. and blower, but with a design thrust of 2,000 lb. This unit was completed in



Rolls-Royce Derwent V jet engine, descendant of Whittle's original unit. Thrust is over 2,000 lb. at full power, while weight is only 975 lb. with oil tank and radiator.

3½ months, being on test in July, 1943. It passed its 100-hr. test at 2,000 lb. in November, and in Apr., 1944, completed its first test flight. This engine was the Derwent, and the Meteor first flew with the new Series I Derwent engines in Mar., 1944, with a thrust of 2,000 lb. from each unit for a weight of 920 lb. Further development was immediately undertaken.

A continuous program, involving many 100-hr. tests, was carried out, culminating in a successful 500-hr. test without strip or major replacement of any kind. The Series II engine gave a 10% improvement in thrust, delivering 2,200 lb. The Series III was an experimental engine to provide suction on the wing surfaces for boundary layer removal. The Series IV gave another 10% increase up to 2,400 lb. thrust. And the Series V (in the Meteor) is



Rolls-Royce Welland jet engine was first built by this firm, employing principles developed by Whittle.

Group Capt. Wilson climbing into cockpit of Meteor "Britannia" before taking off to break world's speed record at 606 mph.

an entirely new unit of which nothing more may be disclosed than that it has developed something like twice the thrust of the original engine, thus enabling the Meteor to achieve its remarkable speed.

The Derwent incorporates a centrifugal compressor on the forward end of a shaft carrying a single-stage axial flow turbine. This main shaft is carried in three bearings and is surrounded by ten combustion chambers, or "cans," which are fed with compressed air from the impeller and with fuel from a high-pressure pump. Fuel is governed by a throttle valve controlled by the pilot. An automatic barometric control reduces fuel supply to burners at altitude, similarly to the automatic boost control on supercharged piston engines.

For starting, fuel is ignited by two ignition plugs, and a fuel cut off is provided for stopping the engine. Flame tubes are mounted concentrically within the chambers, and combustion is completed before the gas enters the turbine vane ring at the rear. Balance pipes between combustion chambers equalize pressure and allow the flames to ignite the fuel in adjoining tubes when starting.

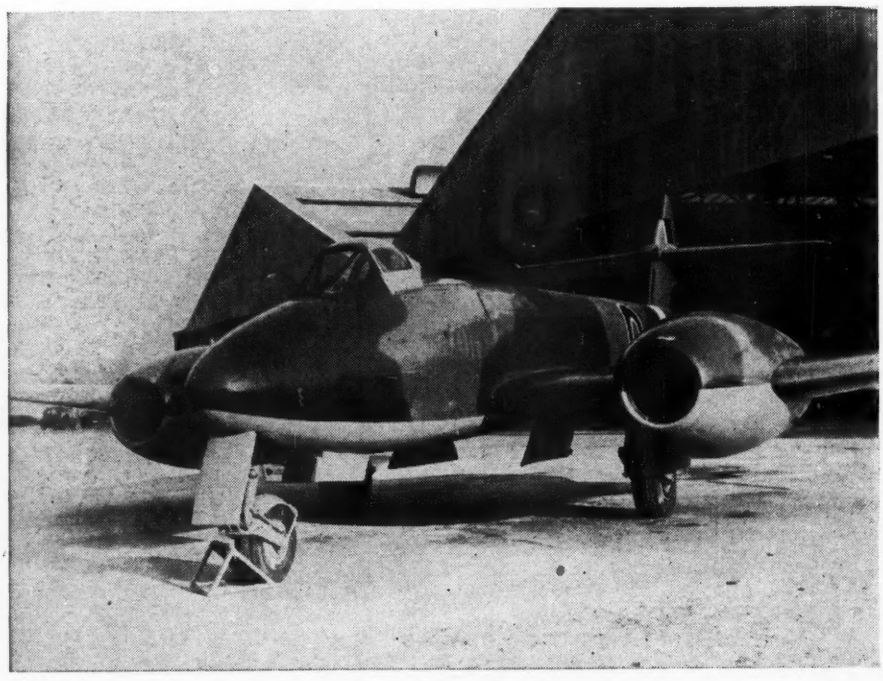
Cooling for the air system, center, and rear bearings, and front of turbine disk, is provided by a small centrifugal fan in front of the center bearing. Air enters through short pipes on the engine front housing and passes through the cooling air manifold to the exhaust outlet at the rear.

Lubrication is obtained from a triple gear type pump to the bearings. The oil is then collected by two scavenge pumps and passes through a thermostatically controlled oil cooler before being returned to the oil tank. The engine accessories, including fuel and oil pumps, generator, and accessory gearboxes, are mounted on the front of the engine, together with an electric starter. The engine is in a streamlined cowling, having a large air intake in front and a propelling nozzle at the rear.

Following ratings were established when the Derwent completed the 100-hr. test: Take off rating, static thrust at sea level, 1,920/2,000 lb.; max. rpm., 16,400/16,600; max. jet pipe temp. 690 deg. C.; cruising rating, static thrust at sea level, 1,550 lb.; max. rpm., 15,000; max. jet pipe temp. 600 deg. C.; idling rating, max. static thrust at sea level, 120 lb.; rpm. 5,000/6,000; and max. jet pipe temp. 350 deg. C.

Leading particulars: Length to exhaust cone flange, 84 in.; jet pipe length, 38.5 in.; max. dia. 41.5 in.; propelling nozzle dia. (internal), 13.08 in.; dry net weight, including oil tank and cooler, 975 lb.; specifications, single stage, double entry centrifugal compressor with double-sided impeller, 20.68 in dia. 20-vane diffuser; throat area, 38 sq. in; compression ratio 3.9 to 1 static, at takeoff; 10 combustion chambers, straight flow with domed colander flame tubes; two igniter plugs (in No. 3 and 10); single-stage axial-flow turbine with 54 blades, dia. 17.38 in.; nozzle guide vane thrust area 60.4 sq. in.; and direction of rotation, anticlockwise, viewed from rear.

Fuel: aviation kerosene, to which has been added 1% of lubricating oil; consumption, max. static thrust, 2,000 lb. at 16,500 rpm., 2,360 lb. fuel/hr.; cruising, 1,550 lb. thrust at 15,400 rpm., 1,820 lb. fuel/hr.; idling 120 lb. static thrust at 5,500 rpm., 470 lb. fuel/hr.; oil consumption, max. all conditions, 1 pt./hr.; normal oil pressure at cruising rpm., 35-45 lb./sq. in.; oil tank capacity, 22 pt.; min. oil for safe operation, 12 pt.; oil cooling system, max. air outlet temp. 300 deg. C.; max. jet-pipe temp. 690 deg. C.; and cruising jet-pipe temp. 600 deg. C.



Gloster "Meteor" jet-propelled aircraft presents several new structural features, with its extra high tail and divided rudder to permit placing horizontal empennage surfaces above jet exhaust stream.

THE ROCKET'S FUTURE INFLUENCE ON TRANSPORT DESIGNS

By DR. MARTIN SUMMERFIELD, *Aerojet Corp.*

Shorter takeoffs, increased loads, and economical high speeds—the key factors dividendwise—are ranged for tomorrow's air transport through use of rocket engines, assist devices, and combinations plants.

ALTHOUGH THERE EXISTS little doubt, at present, of the military utility of the rocket unit, there is considerable controversy concerning its other fields of application.

The case for rockets as an aid in the takeoff of heavy flying boats under certain conditions is apparently settled, but what about the practicability of rocket-assist takeoff, for landplane transports? Is a pure rocket plane feasible? Can rocket propulsion power plants be usefully applied to civilian postwar planes? Can rockets attain sufficiently high altitudes to be useful in scientific work?

Questions such as these can be answered only by engineering analysis divorced from considerations of the romantic appeal. Many people question the utility of the rocket as a prime mover, saying its fuel consumption is too high and efficiency too low for practical use.

Two general propulsive categories come within the scope. One type—the rocket—derives all of the propulsive gas from reservoirs within the vehicle; the other derives a large proportion from the surrounding fluid, either air or water. The turbojet is of the latter type.

Types of Units

Thermal jet engines. General characteristic of the thermal air jet unit is that the propulsive gas is taken in from the surrounding atmosphere, heated by burning of a hydrocarbon, and exhausted at a higher velocity than that at which it entered.

The *turbojet* is a thermal air jet unit in which entering air is compressed by a rotary compressor, heated by the combustion of fuel at compressor pressure, released through a gas turbine that drives the compressor, and then ejected at high velocity through the rearward-directed exhaust nozzle.

An *athodyd* (Fig. 1) is a suitably shaped duct equipped with fuel burners. Instead of using a compressor, it relies on ram compression. The heated gas is exhausted at a higher velocity than that at which it enters, thereby producing a net reaction force. An airplane so equipped must be launched by auxiliary means to provide ram pressure.

The *intermittent jet engine,* like the athodyd, requires no compressor. By equipping the duct with light flap-type check valves, the successive explosions can propel the exhaust gases in only the rearward direction. The unit is capable of continuous operation without ram.

Each thermal jet engine has a characteristic combination of fuel economy, high speed performance, and type of construction that assures it certain applications. All suffer a decrease in thrust as the operating altitude increases, because the mass of air handled decreases with decreasing air density. Thus, a unit that delivers a maximum of 1,000 lb. thrust at sea level at a given speed may be expected to deliver only about 250 lb. thrust at 40,000 ft., possibly less, because of fixed losses and operating difficulties. Where air density is sufficient for satisfactory operation, and at reasonable speeds, each of these thermal jet engines is much more economical in fuel expenditure than the rocket unit.

Rocket Units. One type, sometimes called a *powder* or *solid propellant*

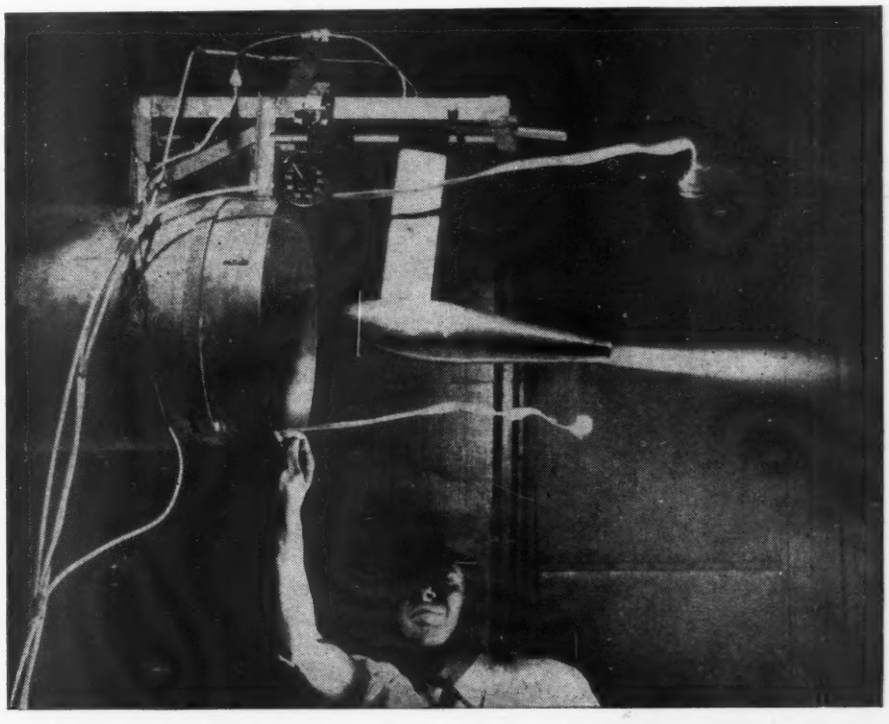


Fig. 1. Under test in 200-mph. forced draft, athodyd has traveled forward on pivoted arm, thus showing a speed surpassing the 200 mph. of the airstream. Inefficiency at this low speed is indicated by visible flame—a sign of poor combustion.

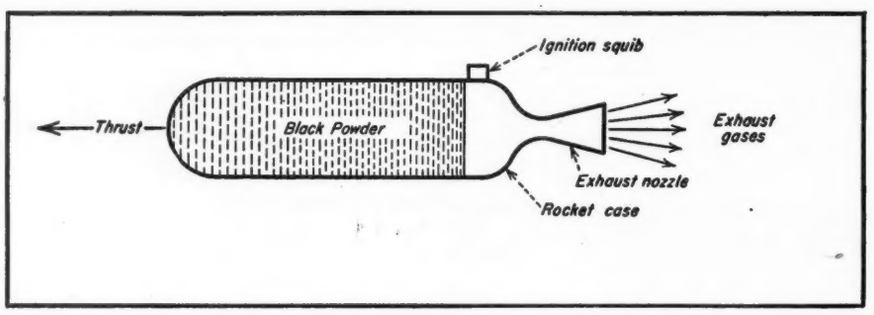


Fig. 2. Typical solid propellant rocket. Powder stick is ignited at back end and burns forward, being treated to prevent burning along sides.

rocket, contains a dry charge of a self-combustible material. Black powder, a typical solid propellant contains about 75% saltpeter, 15% charcoal, and 10% sulphur. It can be burned in the rocket motor chamber without the presence of air, to produce the reaction products indicated in the following equation:

$$KNO_3 - C - S = \underset{\text{gas}}{CO - CO_2 - N_2} + \underset{\text{smoke}}{SO_3 - K_2S - K_2O} \quad (1)$$

Temperature of combustion is about 3,800 deg. F. Construction of a typical solid unit is schematically illustrated in Fig. 2.

Pressure is maintained in the chamber by steady combustion. Products of combustion, forced from the chamber by the internal pressure, expand adiabatically in going through the De Laval nozzle, and their velocity increases.

A second type known as a *liquid propellant rocket* is illustrated in Fig. 3, where a liquid fuel and a liquid oxidizer are fed by pumps into the combustion chamber. The two liquids react after ignition, continuing to burn as long as the supply continues. The products of combustion escape from the nozzle at high velocity. The temperature of combustion of liquid oxygen and gasoline in the ratio of 3.5 to 1 has been calculated to be over 5,500 deg. F.

These conditions of high temperature, high pressure, and high gas velocity presented severe design problems. It was necessary to experiment with uncommon materials to withstand heat and erosive conditions. Combustion of large quantities of propellants, heat transfer at rates far greater than ordinarily encountered, and high-speed supersonic flow required investigation. Despite the new fields to be explored in a short time, the practical rocket unit is a reality today.

In comparison with thermal jet engines, the rocket unit consumes propellants at a much greater rate. However, it is an unusually light prime mover for short durations, it is capable of speeds beyond the limits attainable by thermal jet engines, and it does not suffer a decrease in thrust with increasing altitude, but rather an increase (see Fig. 4).

The rocket unit is that with which we are primarily concerned in this discussion. Applications of thermal jet engines is a subject that requires separate study.

Physics of Rocket Propulsion

Rocket thrust is derived from the rate of change of momentum of the rocket propellant, according to the following equations, provided the exhaust nozzle is designed to give the proper expansion.

$$F = mv \quad (2)$$

where

F = force of reaction
$m = \frac{dM}{dt}$ = rate of mass flow through the rocket nozzle or orifice
v = velocity of the exhaust gases *relative to their velocity before expulsion from the chamber.*

The amount of propellant that must be carried to maintain a required thrust is inversely proportional to the exhaust velocity. It is therefore the objective of the rocket engineer to develop propellants of ever higher exhaust velocity. In general, very high exhaust velocities are associated with higher temperatures and pressures than can be conveniently handled, so that a compromise design is often used.

Some persons have mistakenly thought that the surrounding atmosphere is essential for rocket action to take place, that the exhaust gases "push" against the atmosphere to cause thrust. The truth is that the atmosphere cannot be ignored, but the thrust would be greater, not less, if it were absent. The effect of altitude will be discussed later.

Propellant consumption of a rocket motor can be calculated from equation (2) if the exhaust velocity is determined. The velocity of escape of the gases through the De Laval type nozzle is essentially dependent on the temperature developed in the combustion chamber and the pressure ratio of expansion of the gases.

$$\frac{1}{2}\frac{v^2}{g_c} = HK_{c_p} \times T_c \times \left[1 - \frac{(P_e)}{(P_c)} \times \frac{\gamma - 1}{\gamma}\right] \quad (3)$$

where

H = an adiabatic efficiency
K = mechanical equivalent of heat
c_p = specific heat at constant pressure
T_c = absolute temperature in the combustion chamber
P_e = absolute pressure at exit of the nozzle
P_c = absolute pressure in the combustion chamber
γ = ratio of the specific heats

Calculations are simplified by assuming that the rocket is firing in a steady static condition. Note that exhaust velocity is dependent only on the nature of the propellant and the pressure inside the engine, and not on the thrust or the duration of firing.

The rate of propellant consumption of a liquid oxygen-gasoline rocket unit can be calculated by means of equations (2) and (3), given the following conditions.

Thrust = 1,000 lb.

Mixture ratio = 3.5 lb. oxygen/lb. gasoline

Combustion pressure = 20 atm. at sea level

Temperature of combustion = 5,500 deg. F. or 5,960 deg. R.

Adiabatic efficiency = .90

Specific heat of gases at constant pressure = .45 btu./lb.

Ratio of specific heats = 1.20

$$v = \sqrt{2 \times .90 \times 32.2 \times 788 \times .45 \times \overline{5{,}960 \times (1 - .05^{.167})}}$$

v = 6,900 ft./sec.

The rate of propellant consumption, both oxygen and gasoline, required for the 1,000-lb. thrust rocket is then determined as follows:

$$w = \frac{1{,}000 \times 32.2}{6{,}900} = 4.67 \text{ lb./sec.}$$

It is instructive to compare the rocket with the conventional engine-propeller on the basis of rate of propellant or fuel consumption for a given thrust, say 10,000 lb. Consider an airplane flying at sea level at 375 mph. against a drag of 10,000 lb. If equipped with conventional aircraft engines and propellers, the gasoline would be consumed at the rate of 2 lb./sec. If equipped with a rocket, the rate of propellant consumption would be about 50 lb./sec., or 25 times as much.

It is of interest to compare prime movers on a basis of propulsive efficiency —the ratio of propulsive work done to heat released by combustion of the propellant.

$$e_p = \frac{FV}{wHK} \quad (4)$$

where

e_p = propulsive efficiency
F = thrust or drag in steady level flight
V = flight velocity
w = weight rate of fuel or propellant consumption
H = heat value of the fuel or propellant
K = mechanical equivalent of heat

Let us consider again the airplane flying at 375 mph. against a steady drag of 10,000 lb., and consider, first, that it is rocket propelled. The propellants are consumed at the rate of 46.7 lb./sec. in accordance with previous performance calculation. The heat theoretically released in the combustion chamber by the oxygen-gasoline mixture has been estimated to be 2,500 Btu./lb. of mixture. (This value is equivalent to 11,000 Btu./lb. under conditions of complete burning; almost .4 of that energy is not released because of dissociation or incomplete reaction at the elevated temperature.)

If these values are inserted in equation (4) we find that the propulsive efficiency of the rocket at that speed is 6 percent. On the other hand, the propulsive efficiency of the engine-propeller units in the similar aircraft previously considered is about 20%, or more than three times as much. It should be noted that the propulsive efficiency of the rocket improves with increasing speed of the vehicle, so that it is 12% at 750 mph. (The paradox of obtaining a propulsive efficiency greater than 100% at a velocity greater than 6,200 mph. by means of equation (4) is avoided when it is recognized that the formula must be modified when the velocity of the vehicle containing the propellants becomes comparable with the exhaust velocity of the gases.)

It is clear that at the speeds of ordinary passenger-carrying vehicles, the propellant consumption of the rocket is much too great to compete on the basis of economy. The rocket of the type that has been described cannot be used advantageously for the sole propulsion of airplanes at speeds less than 500 mph. or at altitudes less than 40,000 ft.

In considering what the rocket can do that other propulsion machines cannot do, we must bear in mind several of its important characteristics:

1. It functions well at extreme altitudes, since it does not require the presence of atmospheric air.

2. It consists of simple, inexpensive parts, in comparison with an engine-propeller unit.

3. The dry weight of a rocket per unit thrust is very small in comparison with other propulsion devices, compensating somewhat for its high propellant consumption.

4. The frontal area of a rocket per unit thrust is very low, thus permitting the attainment of high speeds without excessive drag charged against the power plant.

Rocket Projectiles

The rocket is useful when large forces are to be applied for short durations or in applications where the overall weight of the prime mover is to be minimized. An important military application of this type is the use of a high-thrust short-duration rocket to propel an explosive shell attached to its forward end.

An example is the M8 rocket shell which is equivalent in destructive effect to the 105 mm. M1 howitzer shell. The M8 rocket is of 4.5 in. dia., weighs 40 lb., and has a range of 4,000 yd. The howitzer shell has about the same dia., weighs 33 lb., and has a range of 12,000 yd. Only 7 lb. extra weight per round is charged to the rocket; it would take over 500 rounds to make the total weight penalty equivalent to the 3,700 lb. howitzer. It would seem that, unless the greater range of the howitzer is necessary, rocket artillery can be supplied to the fighting front with a much lower investment in weight. In addition, the absence of recoil makes it possible to fire large shells from a man's shoulders or from a combat plane. This type of rocket, fired from a variety of land, sea, and air vehicles, and by the ground soldier, has become one of the war's most significant weapons.

Assisted Takeoff

The Army and Navy have been using rocket devices to assist the takeoff of aircraft. These devices are generally designed to be jettisoned after the takeoffs in order to eliminate the weight and drag of the spent units. Use of rocket assisted takeoff enables heavily loaded flying boats to get off from seas so rough that it would be impossible without such aid. It enables combat planes to take off from small or damaged airstrips and helps carrier planes lift heavy loads from limited flight decks. Overloaded cargo planes are thus able to take the air with moderate ground run.

An interesting application of rocket assistance is found in operation of a Douglas DC-3 transport under the CAA regulations which require that the field shall be long enough to permit the plane to take off and clear a 50 ft. obstacle if one engine should fail just prior to leaving the ground. Table I illustrates how a much shorter field may be used if a rocket assist device is triggered just before the plane leaves the ground and continues to fire until the planes clear the 50 ft. obstacle.

TABLE I—DC-3 Takeoff, Single-Engine Climb, 25,200 Lb. Gross Wt.

Altitude	Jet Thrust, Lb.	Time, Sec.	Takeoff, Ft.	Reduction
Sea level	0	0	5,200	.00
	1,000	12	2,600	.50
	2,000	8	2,000	.62
4,800 ft.	0	0	10,000	.00
	1,000	15	3,300	.67
	2,000	10	2,500	.75

The net load is, of course, lessened by the weight of the rocket unit. However, it can be seen, from the propellant consumption calculated, that in no case is the weight of the rocket unreasonable. Overload in the case of the DC-3 is limited by CAA to 25,200 lb. to permit proper performance in case of subsequent single engine failure during flight.

Studies should be made by airline operators and aircraft manufacturers of the applicability of rocket assistance to other transport planes to determine the benefits that may be obtained under CAA regulations. It may be that wider use of assisted takeoff will await the introduction of devices to assist planes in landing in shortened fields.

High-Speed High-Altitude Craft

Attention was attracted to the high speed rocket plane by the appearance over the Western Front of the German Me-163, a high-speed interceptor. This craft is essentially a flying wing type, and its rocket engine is fed by liquid fuel stored in fuselage and wings. It is said that its performance is far superior to that of any conventional airplane. (See further details on Me-163 in article, page 143.)

Because of the relatively light dry weight of the rocket power plant, the

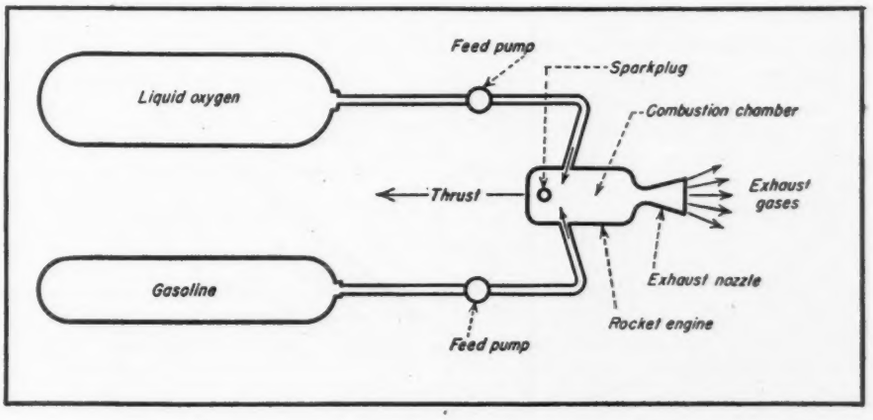


Fig. 3. Pump feed type of liquid fuel rocket using liquid oxygen and gasoline.

TABLE II—Altitude Effects on Performance

Altitude, Ft.	Rocket Thrust, Lb.	Engine-Unsup., Hp.	Engine-Turbo, Hp.
0	100	100	100
20,000	108	48	100
50,000	122	4	30
100,000	137	0	0
Infinity	158	0	0

rapid rate of propellant consumption can be disregarded in flights of short duration, especially at high speeds. To illustrate this advantage of the rocket power plant we will compare it with the equivalent engine-propeller units required to propel an airplane at 600 mph. against a drag of 10,000 lb. at 40,000 ft. altitude.

The dry weight of a 10,000-lb.-thrust rocket power plant can be estimated by comparing it with the German V-2 rocket unit, where the total weight of rocket engine, pumps, turbine, valves, and other parts of the plant, is estimated to be 2,500 lb., and the rocket engine delivers 48,000 lb. thrust. Although this represents a thrust-weight ratio of about 20, it may be assumed that the 10,000-lb.-thrust plant weighs 1,000 lb., to allow for scale effects.

Equivalent engine-propeller units would have to develop at least 25,000 bhp., even if the propellers showed 65% efficiency. These turbosupercharged engines would then be rated at 36,000 bhp. at sea level, and with complete accessories would weigh at least 55,000 lb. dry.

The 10,000 lb. thrust rocket plant, consuming 46.7 lb. of propellant per second, could run for about 20 min. before the total installed weight of plant and propellant would equal that of the dry engine-propeller units. No airplane could fly under these conditions, so that the endurance of the current rocket plane approximates 10 min. at full power.

An interesting graph is shown in Fig. 4, in which maximum speeds attainable by equivalent airplanes, powered by propellers, turbojet engines, and rockets, respectively, are compared. The radial engine is rated at 2,000 bhp., with an installed weight of 3,700 lb. The turbojet is rated at 4,100 lb. thrust at sea level, with an installed weight of 2,000 lb. The rockets are rated at 3,000 lb. and 6,000 lb. thrust, respectively, with installed weights of 300 lb. and 600 lb. The result is most striking at 30,000 ft. for a 10,000 lb. gross weight airplane. Maximum speeds attained are:

Radial engine	400 mph.
Turbojet	500 mph.
3,000 lb. Rocket	550 mph.
6,000 lb. Rocket (extrapolated)	600 mph.

Rocket thrust improves with increasing altitude because of the increased expansion ratio, although the maximum increase possible at each altitude can only be obtained if the exhaust nozzle is designed for the back pressure at that altitude. In Table II, the liquid oxygen-gasoline rocket designed for a chamber pressure of 20 atm. at sea level is compared with an unsupercharged engine and with a turbosupercharged power plant. The efficiency of the rocket is due entirely to an improvement in exhaust velocity as the propellant flow is kept fixed.

It can be seen that the rocket is not limited either as to altitude or speed by its operational characteristics, although the endurance and altitude are limited by the weight of propellant required. Longer durations of rocket flight will have to wait for the introduction of propellants of greater energy. The high speed, rapid climb, and high altitude benefits of rocket propulsion can be combined with the superior cruising economy of an air-consuming engine in planes designed to carry both types of power plants.

TABLE III—V-2 Rocket Trajectory Data

Initial acceleration	1G
Thrust duration, sec	71
Ht. when thrust ceases, mi.	22
V when thrust ceases, ft./sec.	5,300
Altitude, max. mi	68
V, top of trajectory, ft./sec.	3,900
Time to top of trajectory, sec.	193
Horizontal range, mi.	200

The spectacular performance of the German V-2 long-range rocket is undoubtedly one of the great technical achievements of this century, despite its application to destructive uses. The complete missile weighed 24,000 lb., of which 18,000 lb. is the initial weight of liquid oxygen and alcohol. The thrust is constant at 48,000 lb., and continues for a duration of 71 sec. The trajectory has the characteristics given in Table III.

Rocket missiles can be adapted to another purpose—rocket altitude sounding—by modifying for vertical ascent. Using the performance data of the V-2 rocket, an estimate can be made of the altitude it would reach if directed vertically upward.

Neglecting air resistance above 68 mi., the top of the trajectory, the kinetic energy represented by the horizontal velocity at this trajectory peak can be converted into added height, as follows:

$$H = \frac{v^2}{2G} = \frac{3{,}900^2}{2 \times 32.2} =$$

236,000 ft. = 45 mi.

Therefore

$H_{max} = 68 + 45 = 113$ mi.

In comparison. the maximum altitudes attained by other devices are:

Weather balloon....25 mi.
Manned balloon ....14 mi.
Aircraft .....10 mi.

To indicate what can be obtained by means of higher exhaust velocities, it has been calculated that a sounding rocket having an exhaust velocity of 10,000 ft./sec., launched from a 10,000 ft. high station to avoid the drag of the lower atmosphere, can attain a height of 170 mi.

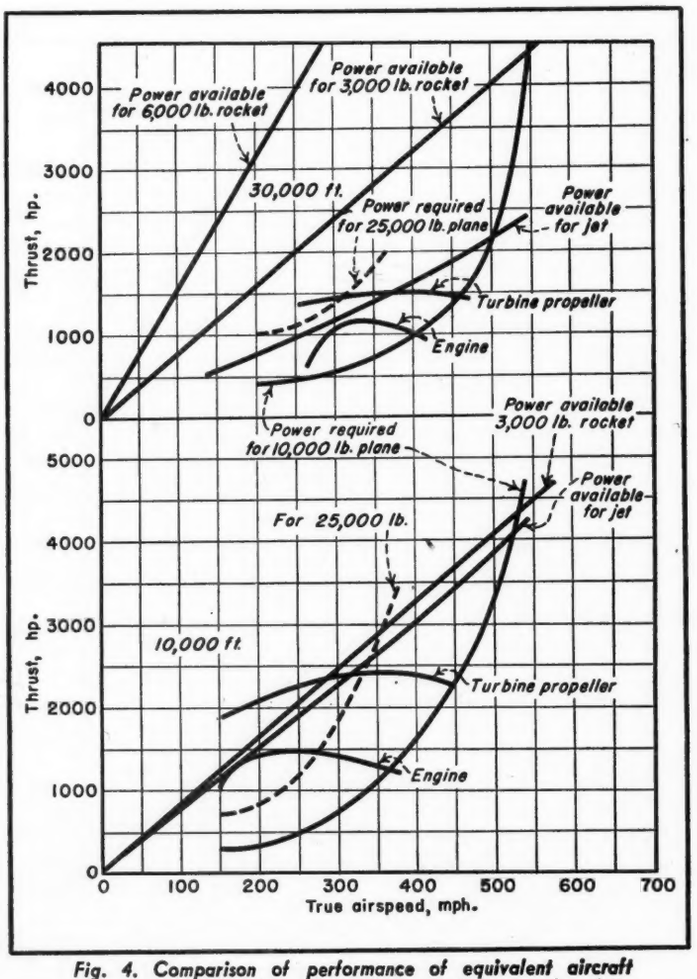
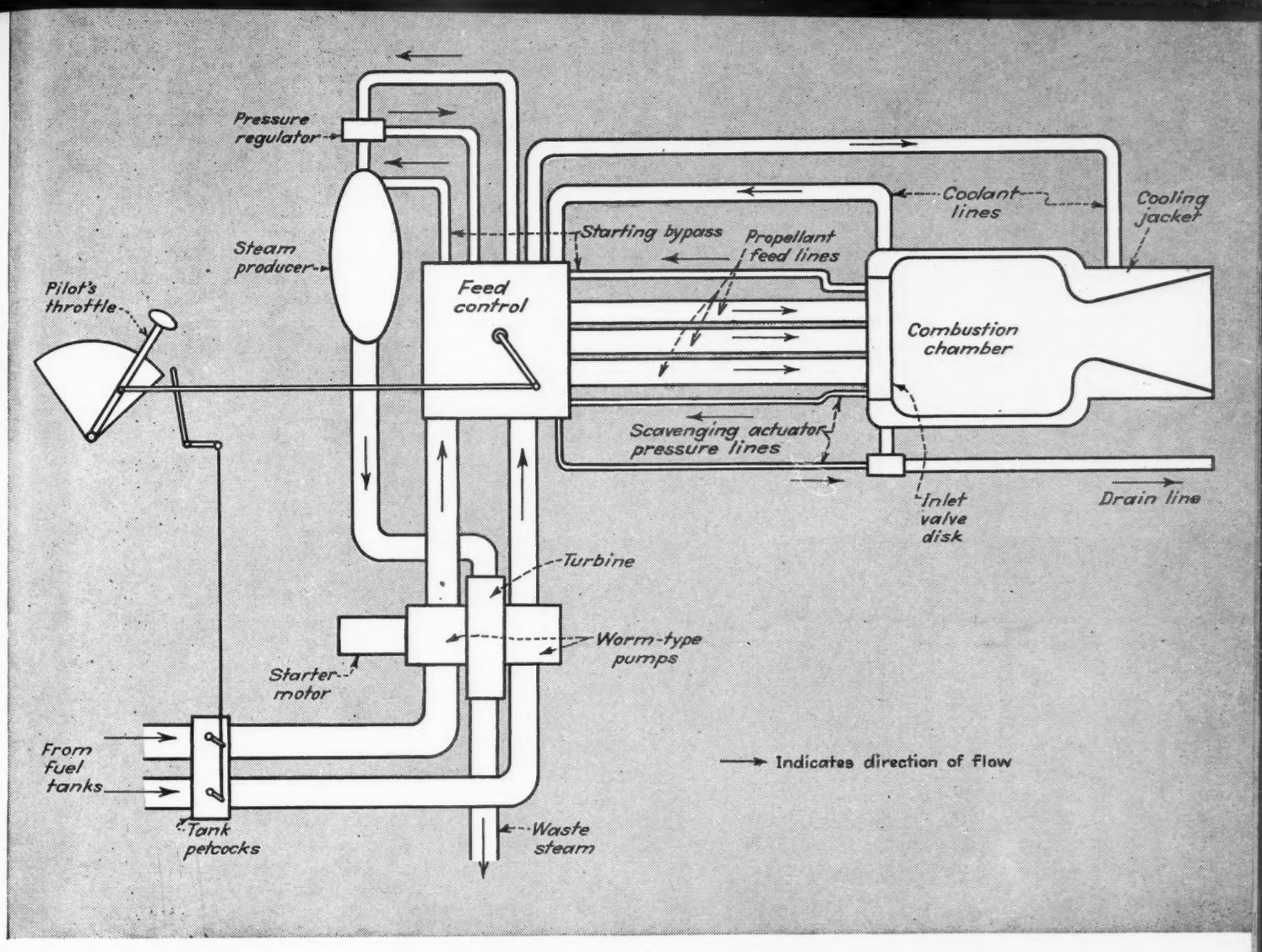


Fig. 4. Comparison of performance of equivalent aircraft equipped, respectively, with propellers, turbojets, and rockets.



Schematic diagram of Walter 109-509 rocket power plant.

How Nazis' Walter Engine Pioneered Manned Rocket-Craft

By ROY HEALY, *Former President, American Rocket Society*

Revealed here are construction and operational details of this unique pilot-controlled rocket engine—symbolizing advanced German thinking on the makeup of power units for high speed interceptors—together with design features of those craft in which it was installed.

IT MAY REASONABLY BE SAID that at the time of V-E day the Germans were approximately one year in advance of this country in the development of rocket power plants for aircraft.

This was not in any measure, as is frequently inferred, the result of superior engineering ability on the part of Nazi research staffs but, rather, attributable to their pressing need for a high-speed fast-climbing interceptor to defend strategic areas from the almost daily attacks of the 8th Air Force bombers. Lack of a tactical requirement for an airplane of this type in our Air Forces—where emphasis was on long range escort fighters—prevented rocket power plant projects from receiving the high priority which they received in the program of the German Air Force.

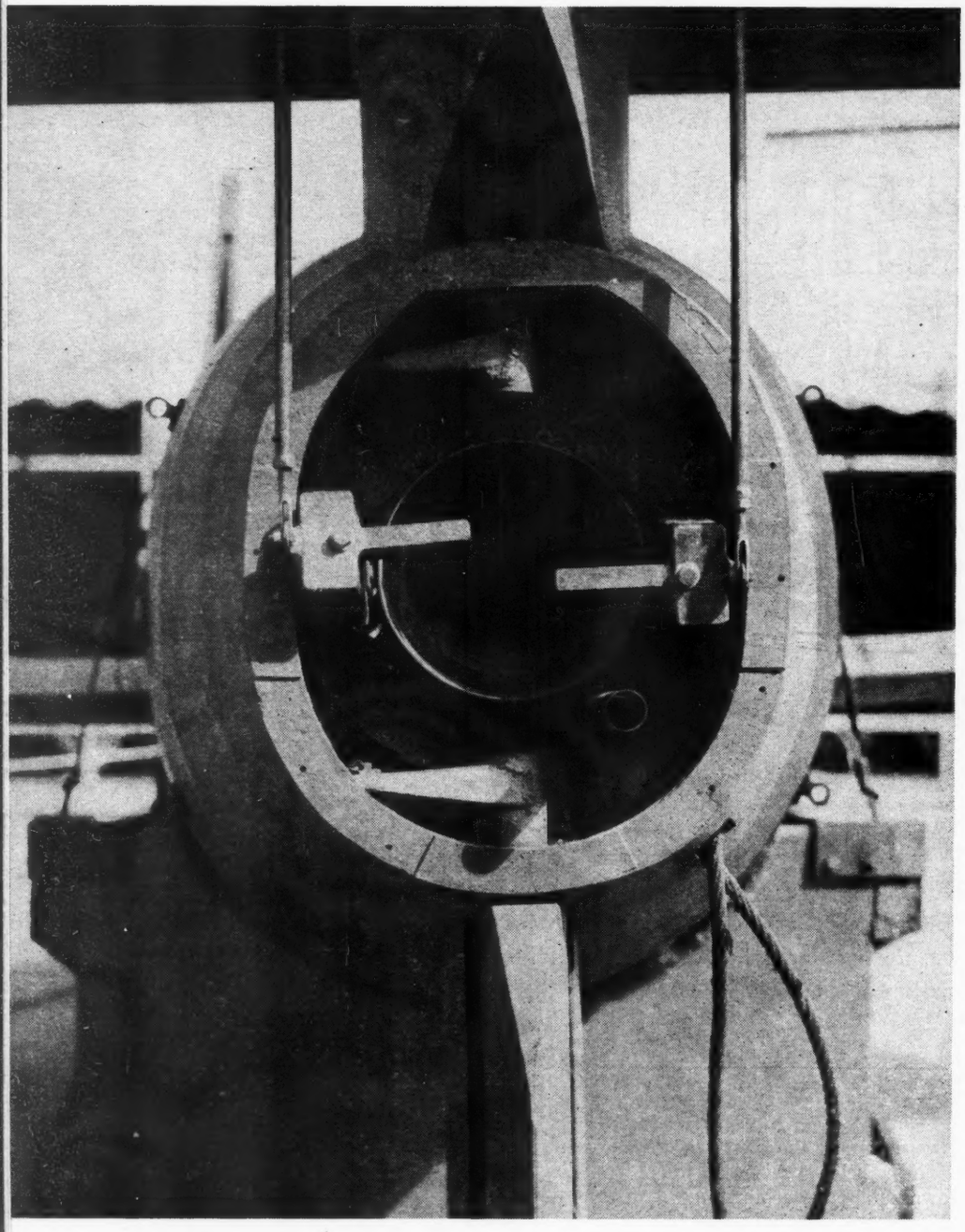
Nonetheless, several groups in our own country, working under Army and Navy sponsorship, succeeded in evolving powerful rocket engines. Visitors to the recent AAF Fair at Wright Field were shown the 6,000-lb. thrust XCALT-6000 and the 3,000-lb. thrust X40ALD-3000 units developed by the Aerojet Engineering Corp. for the AAF. Burning a spontaneously combustible mixture of analine ($C_6H_5NH_2$) and red fuming nitric acid (HNO_3), these power plants may well play a

large part in future military aircraft design.

The Me-163, and some of its subsequent models, were the only rocket-propelled combat craft to see service during the war. The Japanese Baka—while carrying a pilot and powered by solid fuel rockets—falls into the guided bomb category along with the Hs-293. The Bachem BP-20 Natter (German for Viper) was still in the experimental stage of development at war's ending. Both the Me-163 and the Natter were powered by a bi-fuel rocket engine designated as the Walter 109-509, capable of approximately 3,800 lb. peak thrust.

The design of the Me-163 is credited to Dr. Lippitsch, who gained prominence in German aeronautics for his radical departures from conventional design. First seen in action during the Fall of 1944, the Me-163's usual tactics were to flash up and down through the stream of bombers, alternately attacking from below and then above—relying on its 550 mph. speed for evasion of defensive firepower of the bombers. With powered flight time of only 12 min. the Me-163 was restricted in range, although by alternately gliding and operating the engine at low power, the pilot could extend endurance to about 40 min. Equipped with 30 mm. wing root cannon and ammunition supply of 60 rounds per gun, this rocket fighter was a serious potential threat, but it never appeared in sufficiently large numbers to hinder bomber operations.

In contrast to the slender lines of most jet craft the Me-163 is characterized by a stubby teardrop fuselage unit, which is combined with sharply swept-back wings. Nose armor cone contains a wind-driven 200-w. generator for electrical supply. Some later models have been found fitted with tricycle landing gear, but the majority of those used in combat took off on a two-wheeled dolly which was then jettisoned. Landing was effected on an extensible belly skid, small tail wheel, and wing tip skids. In an attempt to increase the duration, some of these craft were equipped with towing eyes and were pulled to combat altitude by tow planes. Differentially controlled aileron-elevators — "elevons" —on the wings make possible the elimination of horizontal tail surfaces.



Closeup rear view of Bachem BP-20 Natter (Viper) showing nozzle of Walter rocket motor with differentially controlled jet deflectors (linked to tail "elevons") extending over nozzle mouth area. Pipe below right deflector is system-scavenging drain line.

Engine Design Features

The Walter 109-509—propelling unit of the Me-163—is also known as the HWK-509. Propellants used in this rocket engine are hydrogen peroxide (H_2O_2, 85 percent concentrate) and methanol (methyl alcohol, CH_3OH). A 30 percent solution of hydrazine hydrate ($N_2H_4.H_2O$) is contained in the methanol to initiate combustion upon coming in contact with the peroxide. Use of this chemical reaction to cause spontaneous combustion of the propellants eliminates need for an electrical ignition system. Power output is controllable by pilot by a throttle on the left side of the cockpit. Settings of the lever are "Off", "Idling", and three stages of power, varying from an estimated 650 lb. thrust, in low, to 3,800 lb. thrust in high power setting.

The power unit is comprised of two subassemblies—the rocket engine and its accessory section—separated by approximately 4 ft. of connecting tubing running through a sheet metal conduit. Empty of propellants, complete unit weighs about 220 lb.

The engine utilizes an alloy steel combustion chamber of cylindrical section with rounded ends. Interior dia. is 9½ in. and length is 11 in. Mounted in the tail of the airplane, the forward end of the chamber contains a 6½-in. valve disk plate into which are set the propellant inlets. Of these pressure actuated valves, twelve are for hydrogen peroxide and five are for hydrate-methanol solution. Centered in the inlet disk is a pressure tap connected to an automatic fuel cutoff valve—operative when engine chamber pressure exceeds safe limits. To prevent burn-out of the engine as a re-

Similarity in positions of linked deflectors and tail elevons is seen in this three-quarter rear view of BP-20 Natter.

sult of high temperatures developed, the methanol is circulated through a cooling jacket, surrounding the motor and nozzle, before being injected into the chamber.

One large fuselage tank and two small cockpit tanks contain 270 gal. of the syrupy hydrogen peroxide, and 130 gal. of hydrate-methanol solution are carried in the wing tanks. Fuel feed system is very similar to that used in the V-2. A portion of the peroxide is drawn off and decomposed to drive a turbine on a common shaft with two worm-type propellant pumps. The steam producer is a porcelain-lined pressure vessel containing a wire screen on which are distributed pellets of calcium (or potassium) permanganate. Feeding a stream of peroxide over this catalytic agent results in violent decomposition into superheated steam and gaseous oxygen. These resultants are piped to the turbine nozzles and, after spinning the rotor, are exhausted through a rectangular waste nozzle below the fuselage.

The accessory section also contains an electric starter on the end of the turbine shaft, centralized fuel-feed control box with linkage control to pilot's throttle, pressure regulator valve for the steam producer, automatic fuel cut-off valve, and a system filter. Thrust of the rocket power plant is transmitted to a built-up bulkhead in the fuselage by two tubular members which act as the engine mount.

Operating Principles

Starting operation consists in initiating the pumping of the fluids but does not entail operation of the power plant with its voracious appetite for fuel. Movement of the control handle to idling position energizes the starter motor and opens the tank petcocks. The starter drives the pump at low power, causing the feed lines to become filled with propellants, but pressure developed is not sufficient to overcome the valve setting in the main peroxide line to the steam producer. A bypass line feeds back a small quantity of peroxide (from a pickup near the inlet valves) into the steam generator. After a few seconds of rotation the turbine is delivering enough power to the pumps to cause opening of the normal feed to the steam producer, and the bypass cuts off.

Observing sufficient pressure registered on an indicator in the cockpit, pilot moves the throttle to the first power setting. This results in opening of three of the hydrate-methanol valves and three of the peroxide valves in the engine injection plate. Intermingling of the in-spraying fuels results in spontaneous combustion—thereafter continuous so long as propellants are fed into the chamber. Decomposition of the peroxide frees nascent oxygen which burns with the alcohol to form the main source of heat. The violent reduction of the peroxide, under heat and catalytic action, releases both thermal energy (adding to the velocity) and superheated steam (adding to the mass) of the efflux.

Temperature of the engine is regis-

tered on a thermometer, visible to pilot, calibrated from 300 to 1,000 deg. C. After the hydrate-methanol solution passes through the cooling jacket, it is returned to the fuel control center where its pressure is adjusted before injection into the combustion chamber. Use of a propellant as the coolant is not a new practice in rocket engines, having originally been suggested in an early design (1903) of Ziolkowsky—Russian pioneer in this field. It offers the advantage of not only cutting heat losses, by achievement of a regenerative effect, but promotes more efficient combustion by preheating the methanol.

High Power Operation

Movement of the control into the second power stage opens an additional inlet for the hydrate-methanol and three additional inlets for the peroxide. The high power setting opens another hydrate-methanol valve (for a total of five) and six additional peroxide inlets (for a total of twelve). The engine operates with a loud roar characteristic of devices of this type and emits a short blue-violet flame.

A system scavenging arrangement is incorporated, which drains all propellants from the lines upon return of the control handle to off position, also shutting off the tank petcocks. A drain tube, connected to the cooling jacket with a pressure-operated valve in its line, serves to exhaust the alcohol, while the peroxide apparently vents through the turbine and waste nozzle. Excessive chamber pressure will also cause shutting of the petcocks and drainage of the propellants.

Interrogation of GAF pilots familiar with the Me-163 revealed that it occasionally blew up in the air. This is understandable, since highly concentrated hydrogen peroxide is capable of sudden violent decomposition. Regardless of its lack of success, the Me-163 is of considerable interest as the first of the purely rocket-propelled manned aircraft. Experimental versions resulting from modification of the Me-163 were the Me-263, 8-328, and a pilotless model intended for aerial ramming.

A trainer version was powered by the steam jet resulting from the reduction of the peroxide when brought in contact with a calcium permanganate solution—no combustion in the usual sense of the word taking place as in the combat version.

German designation of the propellants are *T-stoff* for the hydrogen peroxide, *C-stoff* for the hydrazine-hydrate in methanol, and *Z-stoff* for the calcium permanganate solution.

Bachem BP-20 Natter

The Natter design typified the German trend in short-range high-speed interceptor aircraft, being, in effect, a manned anti-aircraft projectile with a multi-rocket nose. Launched vertically up a tower with the aid of two powder rockets — each reportedly developing a 1,000-lb thrust for 12 sec.—the Natter is said to have a rate of climb of 37,000 ft./min. with an initial acceleration of 1.6G. The stub wings were utilized only to extend the range at the apex of flight—the level of the Allied bomber stream.

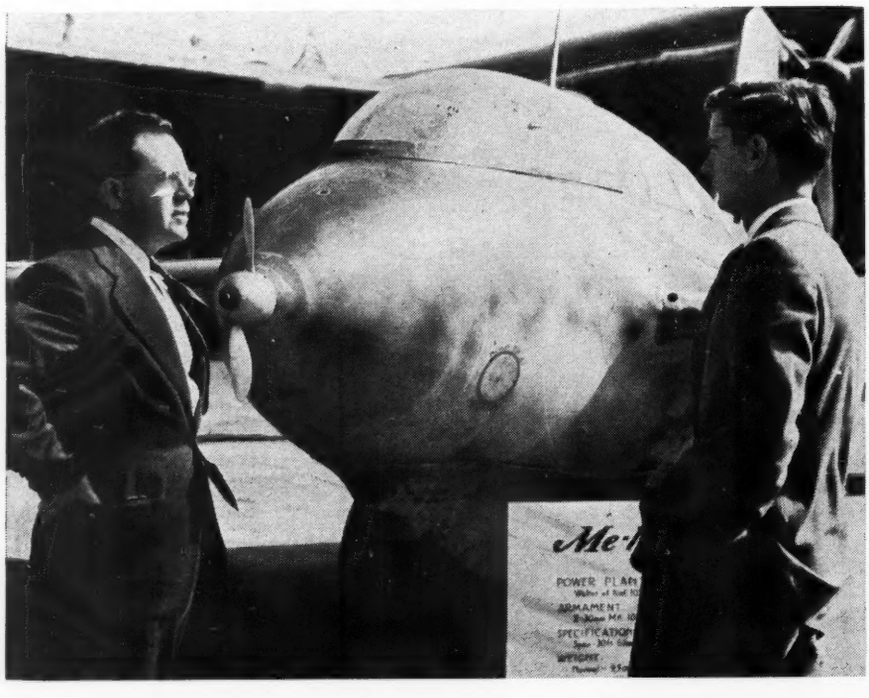
Also powered by the Walter 109-509 rocket engine, the Natter—because of limited fuel supply—has only 80 sec. flight time at full power. At reduced power, endurance may be increased to 120 sec., and by gliding between bursts of power this may be increased to several minutes. No provision for landing is included, since the aircraft is intended—after salvoing its 24-nose-carried 73 mm. rocket projectiles—to split into three parts upon detonation of explosive bolts. Pilot would parachute to safety and the engine unit would also be parachuted for recovery and re-use.

Jet Deflector Control Vanes

One of the more portentous features of this unorthodox aircraft is the use of heavy steel deflector vanes, mounted at the rear of the nozzle mouth, to deflect the rocket jet for directional control. Hinged at their outboard ends, these deflectors are linked to the tail elevons and hence are also differentially actuated. It is safe to predict that this type control will see wide usage in both jet- and rocket-powered craft, since indications point to the conventional control surfaces as a source of major difficulty at transsonic and supersonic speeds.

Specific Consumption High

Immediate widespread adoption of rocket power plants for aircraft is prevented by the ravenous fuel consumption of these engines. Present average unit has a specific fuel consumption of about 1 lb./sec. propellants for each 165 lb./sec. thrust developed, and even the most efficient designs give little more than 200 lb./sec. thrust per lb./sec. consumption. While the engine itself may weigh only about 25 lb./1,000 lb. thrust, the huge weight of fuel required for a reasonable duration of flight currently rules out the rocket power plant for any but auxiliary use in commercial operations. Continued research in engine design and propellant composition will eventually improve the specific fuel consumption ratio. And it may also be expected that one of the initial nondestructive applications of atomic power will be in the form of rocket propulsion.



Discussing design details of Me-163 shown here, are Author Healy (left) and J. V. Balch, ATSC rocket expert. Note generator propeller in craft's armor plate nose, also the retracted belly skid.

Fundamental Design Data of German Craft Fitted With Walter 109-509 Rocket Engine

	Me-163B	*BP-20*
Span, ft.	30.6	13
Length, ft.	19.4	20.5
Takeoff wt., lb.	9,500	3,800
Powered flight, min.	12	2
Max. speed, mph	550	620
Climb to 30,000 ft., min.	2.6	0.8

LAMINATED WINDOW DESIGNS FORECAST BY PLASTIC DOMES

By **LEONARD M. PURDUE,** *and*
GEORGE E. HUGHES, *Boeing Aircraft Co.*

Survival of laminated plastic domes under severest possible tests in laboratory and in combat indicate that future pressurized-cabin designs will include windows of this material.

AS MORE AND MORE AIRCRAFT are designed for high altitude flight with the consequent need for cabin pressurization, there arises a corrolary need for windows having necessary strength, combined with clarity and absence of distortion.

Experiments by Boeing Aircraft Co. on gun-sighting domes for B-29 Superfortresses demonstrate that a material has been found which should adequately fill any demands made by widespread pressurized cabin design.

During the early development of the B-29, sighting domes were fabricated from solid acrylic sheet. This material, easily formed, fulfilled the requirements for optical clarity, but it had relatively high notch sensitivity, low fatigue strength, hence was very susceptible to abuse.

Replacements of solid acrylic domes were high because a slight scratch, crack, or crazing led to failure when subjected to pressure. Failure of a dome in combat meant that the crew had to go on oxygen immediately. Susceptibility of the dome material to abuse also meant that the dome was subject to failure after only slight damage, calling for emergency procedure on the part of the crew, which would operate through the remainder of the mission with reduced efficiency.

In the original design, holes were drilled around the base of the dome. Attachment was made to an aluminum angle by bolts insulated by rubber grommets. In this installation the type of rubber used was extremely important. Rubber that met AAF low temperature specifications proved unsatisfactory because the plasticizers used to obtain the low temperature properties were not controlled. Trouble was also experienced when some plasticizers leached out of the rubber, causing crazing and subsequent failure of the dome.

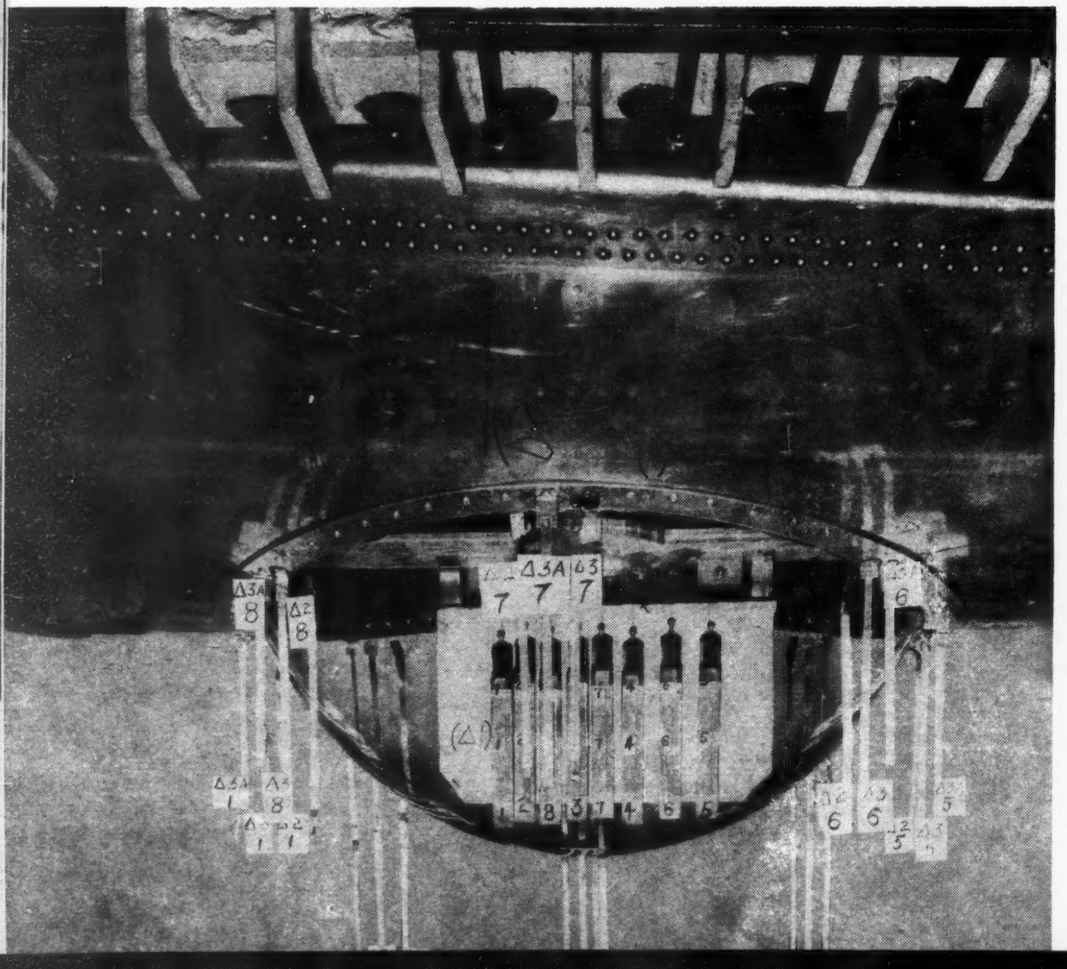
Though tests were run to determine what plasticizers could be used, and specifications were written to prohibit the use of undesirable plasticizers in compounding the rubber, nevertheless the stress concentrations from the bolt holes, and other faults of the attachment, showed the method to be fundamentally unsuitable.

Another type of mounting was tried in which an integral formed flange was installed from inside the airplane. It was pressed against a rubber gasket, with the seal maintained by internal air pressure. The rubber gasket was carefully selected to avoid improper plasticizers. But this installation was not entirely successful because internal pressure and the large size of these domes induced such a high loading that the bending moment at the base of the flange reduced fatigue life to very low

Assembled pieces of single thickness plastic dome which exploded under combined pressure and gunfire. One shot did all the damage. (All photos by Boeing)

Because dome acts as part of optical sighting system, high transparency and freedom from distortion is essential.

Test setup for dome consisted of steel pressure chamber and 24ST panel on which dome was mounted. Tags are for purpose of registering any deflection.



values, compared to those required.

While the solution was in part the development of a method of fastening, it was also a problem in the use of a more suitable material. In their search for a more adaptable material, Boeing engineers discovered a new laminate to which rubber could be successfully cemented.

This material—methacrylate sheet laminated with a polyvinyl butyral core—was under development in the laboratories of the plastics industry, but in the summer of 1943 it was not in production, nor were its properties completely known. The task of discovering whether this laminated sheet was suitable for domes rested with the Boeing engineers. They subjected the material to extensive tests and found that it was adaptable to this use. The AAFATSC was then informed that a more suitable material had been found, and steps were taken to put it into immediate production.

Libbey-Owens-Ford and Pittsburgh Plate Glass were able to start quantity production in a remarkably short time, although not without encountering difficulties. Since the domes acted as lenses in the remote control gun sighting system, high optical clarity and extremely low optical deviations were required. Some undesirable results occurred in the production of the material, such as blushing, scratches, "orange peel" texture, and local aberrations and defects. While many of these defects would not have made the material unusable for normal purposes, they prevented the acceptance of the material for use as sighting domes.

The high requirements necessary in the dome material imposed extremely difficult problems upon the laminators and subsequently upon the fabricators of the material, especially because many of the defects did not appear until after the sheet had been formed. Because it was felt that in spite of these difficulties the laminated sheet would be better for dome fabrication than the solid acrylic sheet, steps were taken to control the quality of the flat sheet and of the finished products, with the result that satisfactory domes are now being produced from laminated material.

Shaped by conventional pressure forming, these laminated domes are mounted in the airplane by a newly developed method of cementing synthetic rubber to the plastic. The cements which were originally used were of such a brittle nature, with insufficient elongation characteristics, that they aggravated edge cracking. Boeing engineers worked with the Swedlow Aeroplastic Corp. to develop a cement which had sufficient elongation to eliminate this defect.

Using this new material, extruded rubber with a semi-circular cross section is

cemented to the inner and outer surface at the dome edge. Attachment of the dome to the airplane is made by metal mounting rings that bear against the rubber and are bolted to the structure. In this type of mounting all loads are distributed evenly along the dome edge. The absence of bolt holes and the fact that no metal bears on the dome prevent any concentration of stresses from being built up. This mounting also compensates for any lack of a perfect fit and supplies pressure sealing.

In determining the effectiveness of the structural bond between the rubber flange and the methacrylate, samples of the bond were subjected to temperature, weather, and stress conditions over long periods. As a result of these tests, a standard method of processing the material and inspecting the bonds was established.

In addition, other tests were conducted on the laminated domes because they were being placed in quantity production and were being made of a material that had not been proved outside the laboratory. In order to carry out these long-time tests at pressures up to 30 psi. and at temperatures between —65 deg. and 100 deg. F., elaborate fixtures were built duplicating the structure of the fuselage in the vicinity of the domes.

One of the things that had to be determined was how the domes would stand up under abuse such as might normally be expected, so tests were set up duplicating operating conditions. Deep saw cuts were made in the domes, and they were cracked by blows, then subjected to pressure. The relatively high pressures carried by these units proved their ability to sustain extensive damage without failure. During the tests, failures were induced by cracking both the inner and outer layers from edge to edge over the apex of the dome and then applying pressure. But even a failure of this nature was not explosive, warning being given that the dome was about to fail. Delamination began to appear as the halves slowly opened and a large bubble formed previous to failure.

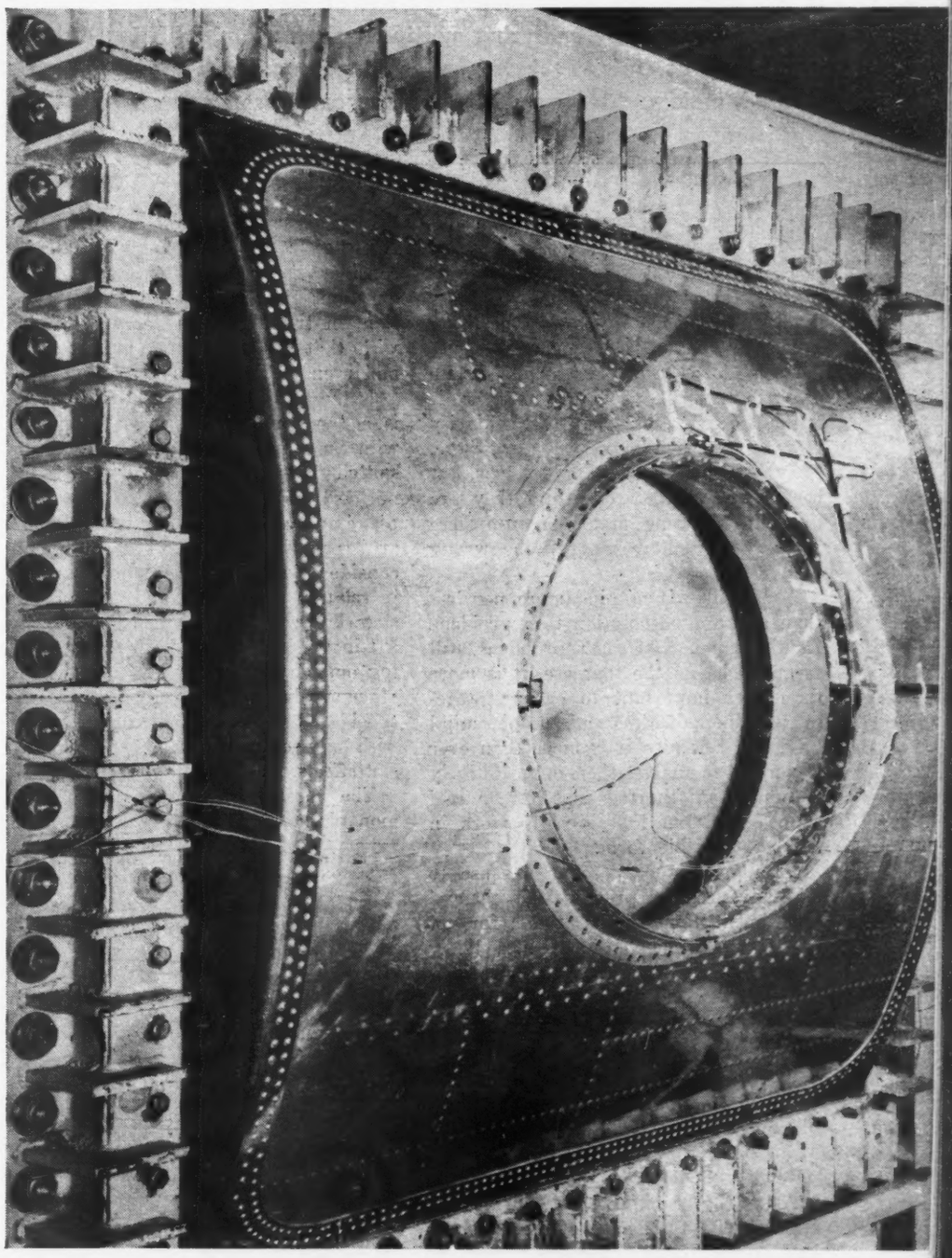
An attempt was made to produce crazing on the dome surface by coating it with solvent. No crazing appeared. This was considered to indicate a symmetry of loading furnished by the mounting design and a lack of any localized eccentric bending.

In addition to the abuse tests, others were conducted to determine how the laminated domes would withstand gunfire. During these test the dome were refrigerated to an average temperature of approximately —4 deg. to —5 deg. F. —the calculated temperature of the vinyl core when the aircraft was operating at —65 deg. F. outside air temperature, with defroster heat blowing inside the domes. Under these simulated operating conditions, and while pressurized at 6½ psi., 20 mm. bullets were fired into the dome. These entered and left the dome parallel to the body surface, but the dome did not fail.

To gain comparative information, duplicate tests were conducted with domes of solid acrylic material. Complete explosive failure occurred with the first shot.

Upon completion of these tests it was felt that conclusive evidence had been gained that the laminated methacrylate domes would withstand projectile impact to a greater extent than the solid acrylic product. Field experience, involving thousands of laminated domes, has borne out these findings. Many airplanes came back to base with flak and shell damage in the sighting domes, yet without disruption of the domes from the airplane.

The highly satisfactory performance of this laminated acrylic material as used in the sighting domes of the Boeing B-29 points the way to many future applications of the material in pressurized enclosures. Its lack of susceptibility to breakage and to explosive failure is seen as a valuable asset in commercial airplanes.



Stress testing of laminated dome with pressure chamber. Bolt type fastening was later discarded because of tendency to start fracture.

DESIGNING TOMORROW'S PERSONAL PLANE

PART VII

By RALPH H. UPSON, *Consulting Engineer*

In this thought-provoking study, the author may appear to be getting 'way off the beam—analyzing multiplanes, unorthodox lifting devices including gas, jets, rockets, and strange landing gear—but he is instead, making a strong case for resourcefulness and open minds.

A NUMBER OF IDEAS in the unconventional category have been touched on previously in this series, particularly in connection with pusher and roadable design.[1] Most of them have called for unfavorable comment. Why? Are such ideas to be condemned because of their novelty? Certainly not. Yet it is the sad truth that the great majority of new approaches don't get anywhere. They fail not because they are new, but because they are wrong, and they are likely to be wrong simply because there are so many more ways to be wrong than right.

A new idea is nothing more nor less than a proposed solution to a problem. As the number of such problems still seems to be on the increase, it is more than ever important to encourage resourcefulness of ideas and an open mind to them. But also it is more than ever important to analyze them quantitatively—to pick out the few that have a real chance, and put those few to work in the best possible form.

Finally, it is only common sense to take advantage of previous thought and experiment along similar lines; for not only is an unconventional idea likely to be wrong, but the chances are it is not even new. Still, changing conditions and corollary developments often put previously rejected features back in the running. It is possible that certain of the items here considered may be found in that class.

How Many Wings?

As might be expected, the wing has attracted its full share of ideas—good, bad, and indifferent. Various monoplane arrangements have been analyzed in previous articles, and the biplane has been briefly discussed (page 145, July 1945 AVIATION); but it remains for us to consider the more general and basic question: How many wings? This question, in turn, is inseparably connected with that of wing type, arrangement, and even of definition.

Is the tailplane a wing? If not, what is a tandem biplane but a monoplane with an extra big tail? Are slots and slotted flaps wings? There is certainly no hard and fast line between a multiplane and a series of slots or slats. For arbitrary disposal, however, we shall consider the tandem biplane primarily in relation to stability and control, and slots between closely spaced airfoils as lift-increasing means, both subjects being outside the scope of this article. In other words, two or more wings are here considered as direct lifting elements, with only secondary stability, control, or slot effects.

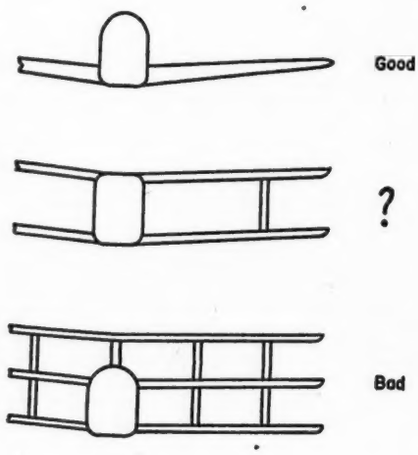
The most economical and efficient monoplane wing has been clearly shown to be the cantilever type (page 140, Aug. 1945, AVIATION). Let us assume that an equivalent biplane design is laid out with equal area to give the desired maximum lift, or to carry the required load at the desired minimum speed. Equality of maximum lift for the basic airfoil is obtained with a gap equal to the chord and about 30 deg. stagger. Induced drag equal to that of a monoplane with aspect ratio 6 is then obtained with about 9 percent less actual span (Diehl's *Engineering Aerodynamics*).

In comparison with a strut-braced high wing monoplane, the bracing of a biplane can be predominantly tensile with some saving of drag, although with more drag than a cantilever monoplane. A pure cantilever biplane is obviously at a structural disadvantage because of its substantially reduced section depth compared to a monoplane. What might be termed a semi-cantilever biplane, however, appears to offer possibilities worth considering, this being a biplane with a single strut fixed in a vertical plane on each side (constituting a Vierendeel truss). Such an arrangement would eliminate the disadvantages of wire bracing; and by proper proportioning, the strut can be made to reduce the wing bending moment to but little over half of its full-cantilever value for the same individual wings.

What this boils down to is to make the biplane double cellule weigh about the same as the rectangular cantilever monoplane wing, with very little more drag. Advantages are not too apparent, beyond the slightly reduced span and the more uniform type of spar structure. There would be more parts to assemble; less room for wheel retraction. Optimum vision and streamlining is with negative stagger, but the latter reduces the maximum lift.

In any case, maximum lift with good flaps will undoubtedly be less than for a monoplane, although quantitative data are lacking; and if flaps are used, the tail is certain at times to be in a disturbing wake. These, however, are what might be termed minor difficulties, and could readily be argued down if suffi-

[1] Parts IV and V, Sept. and Oct. 1945 AVIATION.



cient compensating advantage should be discovered. In other words, even though out of style and of doubtful overall advantage, the biplane still makes sense, and it wouldn't take much to bring it back. But the idea of a multiplane, with still more wings, is something else again.

Consider a triplane, for example. For a similar gap/chord ratio, the further reduction in span is only on the order of 2 percent. If wire braced, the center wing at the neutral axis of the truss is obviously no use as a beam-flange member. If braced by vertical struts only, the wings would have to be about 50 percent thicker (relative to the chord) to avoid substantial increase in weight or addition of another pair of struts. At the best, the structural and production difficulties are substantially increased, and with no apparent justification. This tendency is still further increased with more wings.

In visualing the general case of a multiplane, it is convenient to remember that a monoplane acts on an effective section of air substantially equal to the area of a circle with the span as diameter. Except for marginal effects, a multiplicity of airfoils filling in this circle would not act on more air; it would only, first, distribute the induced downward component more uniformly and, second, allow a larger induced angle and lift coefficient, to any extent that the flow is affected by favorable interference or slot effect between adjacent airfoils.

A good illustration of the latter principle is given by the corner vanes in a wind tunnel, where it is no trick to turn the air through 90 deg. although this is, of course, under special conditions of a closed duct. "Cascades" and other arrangements of multiple airfoils have been investigated from time to time with encouraging results; but all favorable cases have involved such close spacing or such disparity in size between the component airfoils as to put them, as already indicated, into the class of slotted wings, flaps, and auxiliary airfoils, or more broadly, "lift-increasing devices", constituting an essentially different subject. At least one lift-increasing means, however, is sufficiently unorthodox to rate a place among the ideas here considered.

Use of Lifting Gas

It has recently been reported that a large transport plane could almost carry an extra passenger by filling the tires with helium or hydrogen instead of air. This seems quite plausible and suggests a similar possibility for light planes, not only with respect to the tires, but perhaps other vacant space that could be so utilized. Take, as an example, the 3-place airplane designated as Type C (see table accompanying Part II article, July 1945 AVIATION, and reprinted with Part V article, Oct. 1945). The available volume, otherwise unused, in this airplane is readily computed approximately as follows:

Item	*Free-Air Vol. (Cu. Ft.)*	*Static Lift With Helium (Lb.)*
Tires	4	0.20
Wing	94	4.70
Fuselage	82	4.10
Total	180	9.00

Here the static lift is equivalent to the difference in weight between the air and the same volume of gas, taking into account the rated pressure in the tires. The figures are for standard air at sea level and practically pure helium or commercial hydrogen, the volume being taken as 77 percent effective to allow for expansion in climbing to 7.000 ft.

It is obvious that the weight saving by this means is quite minor. In the wing and fuselage, it would certainly be more than balanced by the required sealing material and provision for expansion and contraction, not to mention cost. Although the tires would require no such special treatment, the gain here is negligible.

As for adding extra volume in the form of a separate container,—similar, say, to a droppable fuel tank—the drag of the entire airplane would be practically doubled before enough net lift could be realized to carry an extra brief case, still without counting the added power required to maintain the speed. How then, it may be asked, can any lighter-than-air craft be practical?

The answer is in the geometric magic of mere size. A good streamlined container of circular section 10 ft. long will have a gross lift of about 1 lb.; but a similar shape 100 ft. long will lift 1,000 lb., and one 1,000 ft. long will lift 1,000,000 lb., with less than 1% of the original drag (of the 10 ft. size) in proportion to lift. Similarly, tires ten times the size of those here considered would lift 200 lb. The conclusion: Gas lift has uses, but *not* for small airplanes.

"Nuts to it—a pound of trouble only gets an ounce of lift."

Jet Propulsion

Here is another appealing possibility for reducing noise, drag, and general complications, on which unfortunately the facts and hopes don't seem to join forces. It would be so much simpler if the present ½ lb. or so of fuel per hp./hr. could be used more directly. As it is, the fuel energy has to push a piston, which pushes a crank, which turns a shaft, which turns a propeller, which accelerates air backward, which forces the airplane ahead. Although with more internal complication than is at first apparent, the jet engine accelerates mainly its own products of combustion and intermixed air. For this purpose, substantially the same fraction of the total fuel energy is available, but in a form that produces nearly constant thrust and jet speed relative to the airplane regardless of the airplane's own speed.

For any conditions making the jet speed very much more than the airspeed of the plane, it is obvious that it will leave these products of combustion with a large backward speed relative to the air, and that a correspondingly large part of the original fuel energy will be left as kinetic energy in the jet instead of in the actual propulsion of the airplane. The ordinary propeller avoids this condition by use of the outside air and by grabbing plenty of it to push against.

Why can't a jet do the same thing? It could if some way could be devised for taking in and handling a quantity of air comparable to that handled by a propeller, with a correspondingly small internal loss and without undue external drag or too much direct heat loss. But try and do it on a plane of moderate speed at low altitude on less than about four times the fuel consumption of a good old engine-propeller

combination. And for takeoff and climb, the comparison is more unfavorable to the jet.

Here one might well be reminded of another basic principle underlying all power plant design, but which works particularly against any attempted low speed jet. To get high thermal efficiency, the fuel energy must be released at the highest possible temperature and pressure, essential reason for high compression. It isn't commonly realized that, even with the minimum air quantity required for complete combustion, the power used for the work of compression considerably exceeds the net power output of the engine.

In other words, the useful power is only a relatively small difference between the power absorbed in the compression stroke and the power developed in the expansion stroke of a reciprocating engine. The more you put in, the more you take out, and the more there is to spare. To any extent that extra air is taken into the jet engine, it either reduces the combustion temperature or multiplies the difficulty of compression, assuming that compression could be indefinitely increased (which it cannot after the ignition temperature of the fuel is reached).

Cheap in price, but costly in fuel, is the method of getting both compression and thrust directly from the combustion force, as in the German V-1 buzzbomb. Hence the more efficient turbo-compressor is employed in most jet engines.

Although, to the writers knowledge, this hasn't yet been done under practical conditions, it appears possible with moderate improvement to get as much as 1 lb. thrust per lb. per hr. fuel consumption from a jet, almost regardless of speed. This is a convenient figure to remember for any proposed jet application. A propeller, designed to suit the speed, delivers more nearly constant power so that the thrust then varies inversely as the design speed. For an assumed 80% efficiency, the propeller thrust in pounds becomes:

$$T = 300 \text{ hp.}/v = 600\ F/v$$

where v is cruising miles per hr. and F is the total fuel consumption in lb. per hr. (assuming 0.5 lb. per hp. hr.). Obviously when $v > 600$, $T < F$. Thus, considering propulsion alone, the jet (with $T = F$) would become superior only above about 600 mph. At such speeds, the propeller efficiency drops below the approximate figure used in the above formula, and the jet engine allows a cleaner design which numerically reduces the speed of equal economy, but does not change the fundamental consideration involved. And after all, *any* single-engine installation, of moderate size in relation to the fuselage, can be made reasonably clean.

Jet propulsion naturally fits for very high speed, otherwise not. And very high speed (meaning well over 400 mph.) is too hot to handle for the average private pilot and his bankroll, by *any* present known method. (Correct me if I'm wrong!) Nevertheless, we have still not quite exhausted the possibilities for adapting the jet to personal use.

Propjets Turbojets, and Rockets

There is one part of even a lightplane that travels at a speed in the range we have been talking about—that is, the propeller itself. Then why not jet-propel the propeller? The jet and propeller blade would then have a similar relation to that between the propeller and wing. The normal direct-connected propeller is incapable of lifting the entire aircraft directly, but it can do so indirectly by pulling a wing through the air. In similar manner, a jet engine is unsuited for developing directly the thrust required by a lightplane, but indirectly it might do so by pulling propeller blades through the air.

According to the propeller formula already given, the thrust of a 150-hp. engine at 150 mph. would be 300 lb. Assuming 2,500 rpm., the torque from 150 hp. would be:

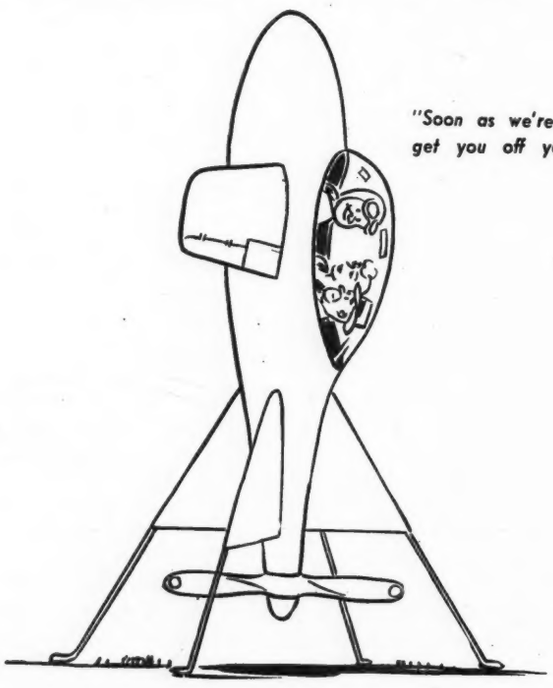
$$\frac{150 \times 550 \times 60}{2500 \times 2\pi} = 315 \text{ ft. lb.}$$

which means that on a mean arm of a little over 3 ft., the required jet thrust would be only about 100 lb. The fuel consumption, by methods at present attainable, would still be on the order of 33% more than for the conventional engine, but this moderate difference might be counterbalanced by superior cleanness, lightness, and initial cost saving, if excessive weight and drag of the propeller blades themselves could be avoided.

The final answer would, of course, depend on more complete analyses of specific arrangements. For example, each blade might incorporate a small jet engine, with fuel fed through the hub. Although many difficulties of detail are apparent, still the idea appears basically sound and possibly worth serious consideration.

The only other possibility of satisfactorily using the jet principle for regular propulsion of a lightplane appears to be by means of internally moving parts designed to travel at suitably high speed. In other words, a gas turbine. Actually, as has been indicated, a jet engine already has a turbine to compress the charge; and it only has to be enlarged a little to drive a propeller. But authorities on this subject are none too optimistic about the immediate prospect of a low-power gas turbine to compete with present reciprocating engines (see page 131 June 1945 AVIATION). The admission of considerable air is required for cooling; blade clearance is quite a problem; and accurate fabrication and assembly of so many small parts is hardly conducive to economy.

In general, while the problems of a reciprocating engine increase with size, those of a turbine seem to increase as its size is reduced. Still, with further improvement in heat-resisting materials, efficient compression, and satisfactory means for gearing down a rotational



"Soon as we're up, I can get you off your backs."

speed on the order of 30,000 rpm., there appears to be nothing basically wrong in the hope that some day we may have a small engine of the turbine type with a weight and size far less than for present engines.

Finally, no discussion of jets would be complete without at least some mention of emergency or short-term use. Although a steady drain of several times the normal fuel consumption would unduly restrict the range and soon leave the owner broke, even a *very* wasteful use of energy for a few seconds might readily be tolerated for special purposes. In a forced landing, what's it worth to be able with certainty to get into that small pasture, and out again? Ten dollars? A hundred dollars? Name your own figure. For such purposes, standardized, expendable rocket units look like at least one good answer, subject to finding satisfactory answers to several component questions: Where is the best mounting for such units? If in the wings, can we be sure that they will fire at the same time and with near enough equal force to avoid a dangerous disturbing moment? What about the risk of fire in a forest clearing?

Although the simplest application of rockets is for producing thrust force, cannot they also be arranged, under control of the pilot, to discharge at a forward and downward angle to supply a braking force at landing? (A low wing with sufficient dihedral would provide mounting on a transverse line through the C.G.)

Would it be feasible and advantageous to distribute a rocket jet along a large part of the wing span on the top surface, acting backward, tangent to the surface, where it would not only produce thrust, but also increase the wing lift by energizing the boundary layer? (For this purpose a force vector below the C.G. would help attain the desired high angle of attack.)

Emergency Rotating Wing

Here is another fancy idea for overcoming the admitted disadvantage of an airplane with respect to takeoff and landing. Either the wing itself can be arranged to auto-rotate like an autogiro, or the airplane with more or less conventional fixed wing can be equipped with a separate rotor for emergency lift. It is the writer's opinion that no expensive complication of this kind is presently justified for landing assistance alone. The modern lightplane, with glide control means, requires much more distance to take off than to land; and to take care of a possible forced landing over rough country, standard parachutes are economically hard to beat.

Even with helicopter blades capable of indefinite, vertical climb, the value of the added complication appears highly questionable, except in the case where one wishes to "go the whole way" and get a regular helicopter. In combination with an airplane, the mechanical complication of the usual rotor drive with torque control means would certainly spoil the elementary simplicity of the airplane, and even the folded stationary blade with its mounting would necessarily add considerable drag.

Here again, the jet principle might be of material help. Although even an emergency high-powered jet would be of little help in direct lift, it could in-

"A special truck for takeoff. Sounds possible. But I can't expect to land on it, so I'll have to dope out some way to stop the prop horizontal before landing."

directly spin a good sized blade at sufficient speed to lift the entire aircraft, and would at the same time automatically take care of torque. If an expendable rocket unit, instead of the more costly jet engine, should be used for the purpose, it would simplify otherwise troublesome problems.

With further advances of knowledge in the supersonic field, it may be possible to employ, for short periods of time, rocket-driven rotors much smaller and lighter than would be required for continuous use on a regular helicopter. Dangerous wing interference might then have to be avoided by something like tandem wings or tandem rotors—or perhaps by standing the whole airplane on its tail and using the propeller itself. All in all, this kind of scheme must still be regarded as in the class of mere possibility, entirely lacking substantiating data, at least in the class for private operation.

Shrouds and End Plates

On the subject of takeoff, the improvement most directly available is, of course, a variable-pitch propeller, a means too well established to be classed with the devices here considered. An alternative and relatively simple way of boosting thrust for a given diameter and/or reducing the diameter is to shroud the entire propeller with a wide (preferably non-rotating) ring of suitable airfoil section.

There are two beneficial effects: First, reduced tip loss and, Second, less slipstream contraction. The first of these restrains the vortices at the individual blade tips in similar manner to end plates on a wing (see below), especially effective at full speed when each blade bites off a relatively thick chunk of air; but the gain to be expected from this source is on the order of only about 3%.

The second effect is more directly explained by the forward component of resultant force set up by the contracting slipstream as it flows past the shroud ring. This effect operates more at low speed. For example, the static condition makes the final speed of the slipstream twice its average value through the propeller disk, and hence half the section area. For this condition, if the shroud ring could be made fully effective it would maintain equal static thrust with half the disk area or 29% less propeller diameter; but 15% reduction is a more reasonable expectation, especially considering a reasonable limitation of ring width and the loss of thrust at the higher speeds.

Then, of course, the weight and drag of the shroud itself have to be taken into account. Altogether the net benefit appears at least doubtful for a tractor propeller, considering not only the direct weight and drag, but also additional tail area to balance the destabilizing effect of the shroud. But for a pusher propeller, mounted where it should be—at the tail[2]—where shroud area can be made effective tail area, the picture is very different. There, everything works together for good, including what is particularly important for a pusher—almost perfect protection for persons on the ground.

In a somewhat similar class are end plates for wings. Based on test results from rectangular wings (NACA TR267), it can readily be shown that the increase of *effective* span from using end plates is about the same as the *actual* increase of span that could be had by adding half the total end-plate area to the wing itself—which doesn't appear to make much of a case for end plates. But again conditions are quite different at the tail. Here the vertical stabilizing surface needed in any case may as well be used in the form of end plates on the tail plane.

"May as well" is just about the right way to put it because, even at the tail, end plates or dual fins are no great panacea. True, the effective aspect ratio of the horizontal surface is increased but, by dividing the vertical surface, its

[2] See Part IV, Sept. 1945 AVIATION.

own effective aspect ratio is often decreased, and there are certainly more parts to assemble. On the other hand, the total airplane height may be somewhat less, and the rudder force can usually be exerted at more nearly the C.G. height. Incidental considerations have to do with whether you want a fin and rudder in the slipstream or not. In most cases, the writer is inclined to favor the single fin, but you may almost as well toss a coin and call it "fielder's choice".

How Many Wheels?

Judging from Patent Office records, one of the most attractive targets for new ideas is the landing gear. Although this is not the place to attempt a treatise on landing gear design or discuss its almost infinite possible arrangements, we may at least be able to narrow the field somewhat with reference to the most suitable number of wheels.

All the landplane designs thus far considered have had three wheels, which is obviously the least number giving free-rolling positive static stability on the ground. There are certain advantages of four wheels (arranged automobile-fashion), particularly for high-wing monoplanes,[3] the float-type amphibians (Part VI of this series), and roadables. But for the generally desirable low-wing landplane, three wheels appear better suited and certainly lighter, whether arranged in the nose-wheel or tail-wheel configuration. An alternative four-wheel arrangement, with tandem main wheels and supplementary wing-tip wheels, is really a variant of a two-wheel bicycle gear, of which more will be said below.

The old standard arrangement of two main wheels and a tail skid had its day, served its purpose, and has been retired for obvious deficiencies. The only form in which it might be worth reviving is with the wheels close to a transverse line through the C.G. to prevent ground looping and aerodynamic bounce, and a nose skid (in addition to a tail skid) to take the braking moment. A modest saving in weight might thus be effected with some loss of positive ground steering due to dependence on rudder and/or differential brakes.

The perennially proposed tandem or bicycle arrangement of two wheels, similarly requires two skids or their equivalent, at the wingtips. Ground control here depends on one of the two wheels being steerable, but such steering cannot be mechanically coordinated with the air steering because of the reversal of rolling control in a cross-wind landing, as pointed out in Part III (Aug. 1945). The incentive for this arrangement is naturally small in a low-wing design, which provides almost as good a mounting for laterally spaced wheels.

That a single wheel is by no means impossible is proven by its long and successful use on gliders. In fact it has one advantage over the bicycle arrangement in that it restores full lateral control to the rudder and ailerons; but there is still a discrepancy between lateral control in the air and on the ground, which argues against any direct coordination of controls such as the two-control system. Also a basic difference between gliders and powered airplanes is in the fact that the latter *can* be taxied, and therefore makes more important the kind of landing gear that is generally suitable for this purpose. Then there is the old problem of propeller-ground clearance.

This hypothetical process of reducing the number of wheels would logically end with none, thus returning to the condition of the original Wright plane. It would be like a "roadable" development in reverse (see Part V, Oct. 1945). It would also reverse the general trend of airplane design, which has proceeded through various steps—involving wheels, improved tires, shock absorbers, brakes, and steering means—to a steadily increasing facility of ground maneuvering. Yet this trend might readily be reversed by development of the right kind of ground equipment designed to be left on the ground.

The present need of carrying complete ground equipment in flight is one of the very greatest handicaps to airplane performance and economy. Referring to our "score card" in Part II (reprinted in Part V) of three-place airplanes, design Type A represents the most advanced type of landing gear. Complete with retracting mechanism, this gear weighs 233 lb. If this weight were eliminated, the indirect saving in the wing, power plant, fuel, and general structure would be 0.9 x 233 = 210 lb., or a total of 443 lb.[4] The gross weight would be reduced from 2,200 to 1,757 lb., the engine power from 129.5 to 103.5, cruising power from 79 to 69, fuel from 35.5 to 31 gal., weight empty from 1,412 to 996 lb., with same wing loading and power loading, same cruising speed and range (although slightly reduced maximum speed and climb), and same load carried in persons and baggage.

Complete elimination of the landing gear, with nothing to take its place, may of course be put down as an impractical dream; but it gives a good idea of what we are paying for making takeoff and landing an *airplane*-function instead of an *airport*-function. And the figures just given make no allowance for the large further saving in engine power, wing area, and other items, that would accrue if the plane were designed throughout for air performance only.

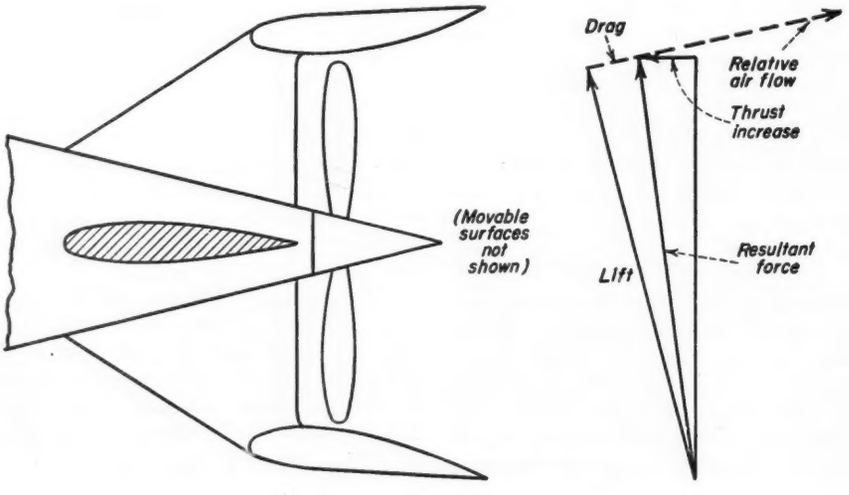
Present landing gear is used only for the plane that carries it; airport "landing gear" (more properly taxi and takeoff gear) could be used for every plane that comes in. Something to think about, anyway!

But what specific means can be found to make practical such an apparently wild scheme? Well, that's something else again. Here, from this distance, we can only point out the woods, not the trees. But, after all, that is an advantage of being well off the beam occasionally—you catch glimpses of such beautiful views that would otherwise be missed. Then, on some other flight, you can get closer, see what those trees are, and perhaps find some way of really getting to them.

In his next article, Mr. Upson will discuss these pertinent questions: How many engines? And how many places?

[3] New Developments in Simplified Control, Dec. 1942 *Journal of the Aeronautical Sciences.*

[4] See principle of primary and secondary weight, Part V, Oct. 1945.



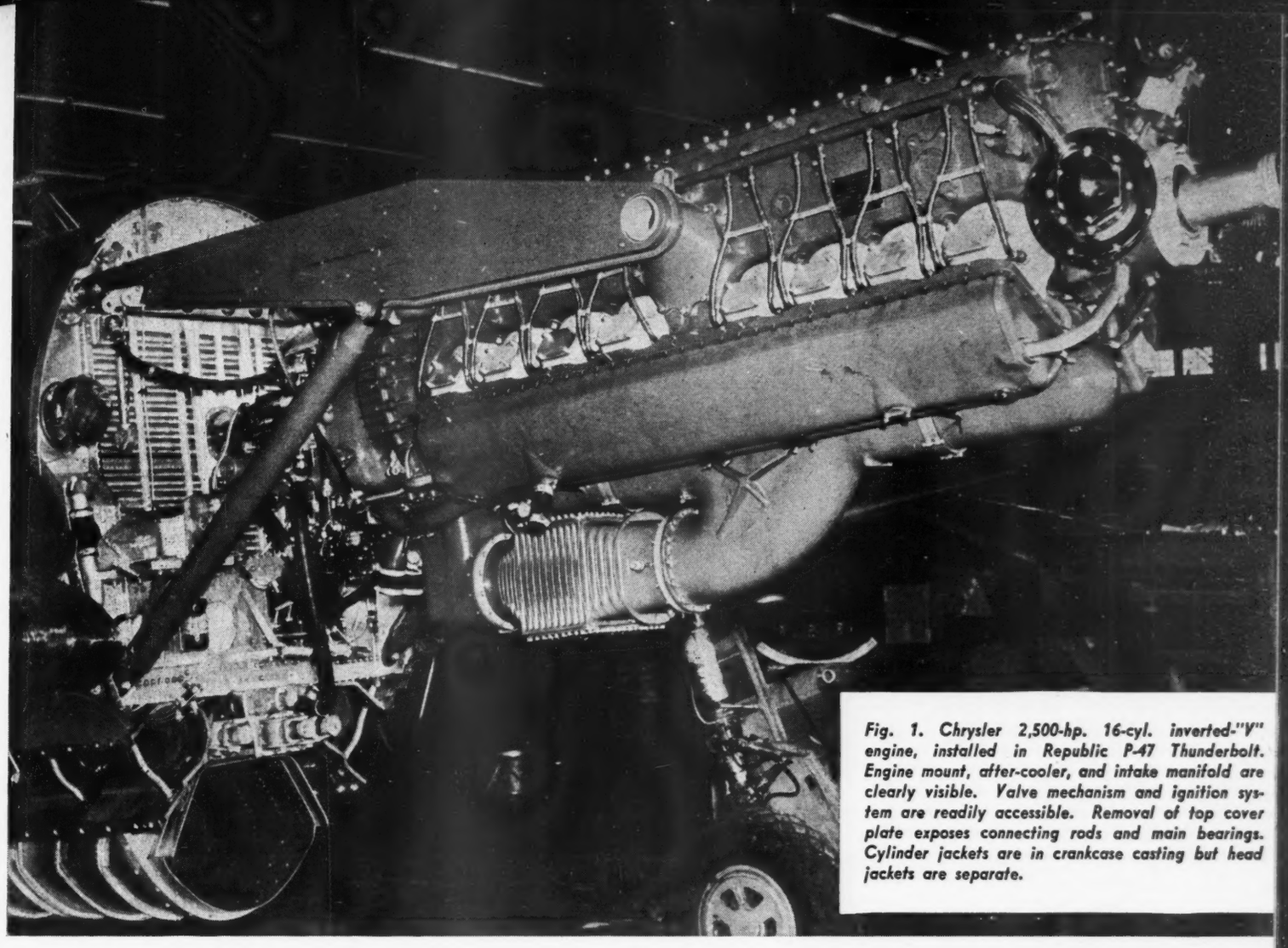


Fig. 1. Chrysler 2,500-hp. 16-cyl. inverted-"V" engine, installed in Republic P-47 Thunderbolt. Engine mount, after-cooler, and intake manifold are clearly visible. Valve mechanism and ignition system are readily accessible. Removal of top cover plate exposes connecting rods and main bearings. Cylinder jackets are in crankcase casting but head jackets are separate.

New 2,500-HP. "V" Engine Features Lightness, Accessibility

Weighing less than a pound per hp. and designed for ease of servicing and economical mass production, Chrysler's new 16-cylinder engine will pass through a 3 ft. hoop with inches to spare.

CHRYSLER'S LIQUID-COOLED 16-cyl. inverted "V" aircraft engine was planned for mass production. It was flight tested in a converted Republic P-47 which developed speeds approaching 500 mph.

The engine weight scales 2,430 lb. or less than 1 lb./hp. It measures 10 ft. 5 in. long and was originally designed to pass through a 39 in. dia. circle. Actually it will go through a 33½ in. circle when the supercharger, after-cooler, and intake duct are removed. Accessibility was designed into it from the start. It was also designed to be practically vibrationless—a feature obtained by the unique mounting and arrangement of the drive.

Other features are its two-piece crankshaft bolted to the drive pinion, which is located at the center of the engine as is also the propeller shaft gear, providing a reduction of 2.4 to 1 or 1,350 rpm. at normal engine speed. Crankcase is a one-piece aluminum casting with two heavy transverse vertical walls at its center where the reduction and timing gears are located. Externally on each side is a trunnion supporting the entire weight of the engine, located almost at the center of gravity. The cylinders are held to the crankcase by ring nuts at their base, accessible when the top cover is taken off and easily removed with a special tool.

Cylinders have steel barrels with cast aluminum cylinder heads screwed on as in conventional practice. Part of the crankcase forms a water jacket for the cylinder barrel. Two round Neoprene rings in grooves seal both ends of each cylinder in the water jacket.

Two valves per cylinder are used, operated by a single camshaft running below the center of the cylinder head. Independent rocker arms operate intake and exhaust valves. Two-stage super-

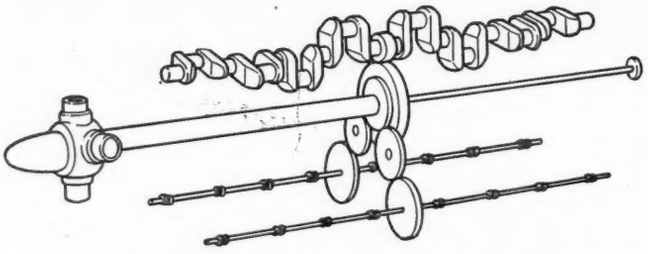


Fig. 2. Diagram showing relationship of parts of power transmission system. Two 4-throw crankshafts are bolted together onto center pinion, which drives propeller and accessory shafts through reduction gear. Idlers transmit motion to camshafts (bottom of diagram). Center drive eliminates perceptible torsional unbalance.

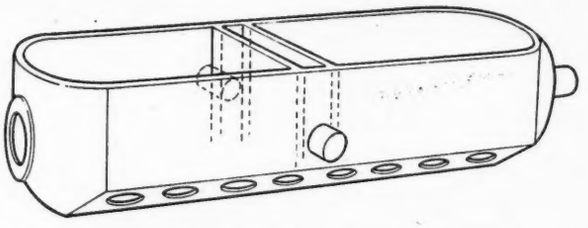


Fig. 3. Sketch of crankcase shows one-piece construction, with heavy cross members in center, between which drive gear is located, with support trunnions at sides. Third trunnion (seen at righthand end) is pivoted to firewall. Casting forms coolant jackets for cylinder barrels, which are Neoprene-sealed at ends.

charging is used—the primary is a turbosupercharger, while the secondary is mechanically driven. Both intercooler and after cooler are used. The latter is seen in the illustration of the engine.

The method of mounting the engine is unique in America. Two arms project from top of the firewall to the trunnions on each side of the crankcase. Compression members beneath them are attached to bottom of firewall. Ball and socket mounts at firewall and rubber bushings at the trunnions give complete flexibility to supports and relieve engine from external stresses caused by distortion of the airframe.

Ideal "controlled vibration" is obtained with this design. Each crankshaft counterbalances the other for couples. Since there is no heavy propeller mass at the end of either crankshaft, torsional vibrations are negligible. Because the gears are at the vibrational node no vibration dampeners are necessary. The propeller and accessory drive shafts are parallel on opposite sides of the driven reduction gear. Propeller and accessory drive gear trains (including high pressure supercharger) are balanced against one another and thus torsional vibration is controlled in the secondary drive.

The two camshafts are driven off a timing gear attached to the propeller shaft, through two idlers. These shafts being driven at the center are in almost perfect torsional balance and hence do not contribute any vibration to the power system proper.

Support for the engine at its center of gravity is also important. The double walls at the center can be made heavy enough to support the load, but each half of the crankcase can be built lighter since each has only half the dynamic load of the usual in-line engine.

Furthermore, support of the engine in trunnions at its center of gravity, and at the rear end in a third trunnion with axis at right angles to the first two, permits rubber mounting and complete control of the degree of coupling. This provides a flexiblity of mounting unobtainable with any four-point support. Vertical and lateral loads are taken by the central trunnions. Yaw, roll, and side thrusts are taken by the trunnion at the rear of the engine. Thus rubber type bushings can safely be used at the three supports, with the engine structure completely insulated from outside stresses.

Forked connecting rod is full 'H'-section with a slight channel on each side. This gives an unusually light, yet strong, rod. There are continuous edges throughout without abrupt changes or notches to act as stress raisers. The bolt holes are countersunk for the same reason.

Connecting rod bolt is also unique, since two things are done to assure positive and controlled loading. The head and nut both bear against a 60 deg. recessed face, which allows only a tension load on the bolt, the head adjusting itself to eliminate any bending forces. It acts like a ball and socket joint. The nut has the same 60 deg. angle to eliminate bending stresses.

The nut also has a safety feature. The load is not applied to the threads at the edge of the nut, but part way up. A collar like extension beyond the 60 deg. bearing surface prevents excessive loading on the starting thread.

These are just a few of the features of this interesting engine design.

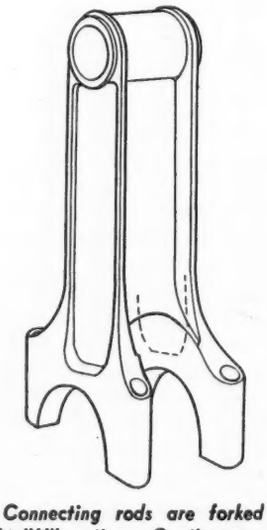


Fig. 4. Connecting rods are forked and of very light "H"-section. Continuous curves replace old-style sharp internal corners, removing causes of stress concentration.

Table I — Chrysler Aircraft Engine Data

Hp., max.	2,500
Hp., normal	2,150
Wt., lb.	2,430
Wt./hp., lb.	0.972
Type	Inverted "V"
No. cyl.	16
Displacement, cu. in.	2,220
Bore, in.	5.80
Stroke, in.	5.25
Stroke-bore ratio	0.905
Compression ratio	6.5 to 1
Valves per cyl.	2
Camshafts	2
Valve operation	Rocker
Reduction gear ratio	2.43 to 1

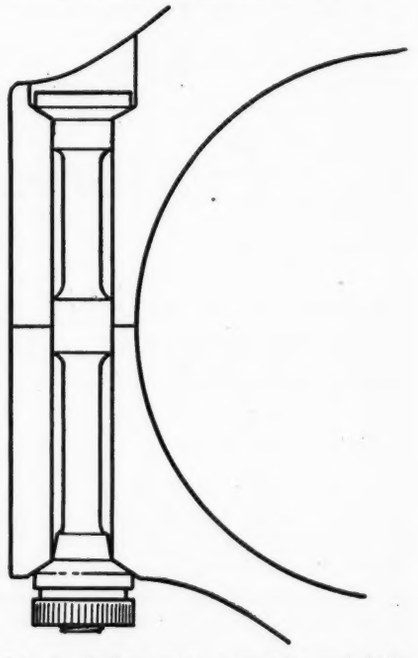
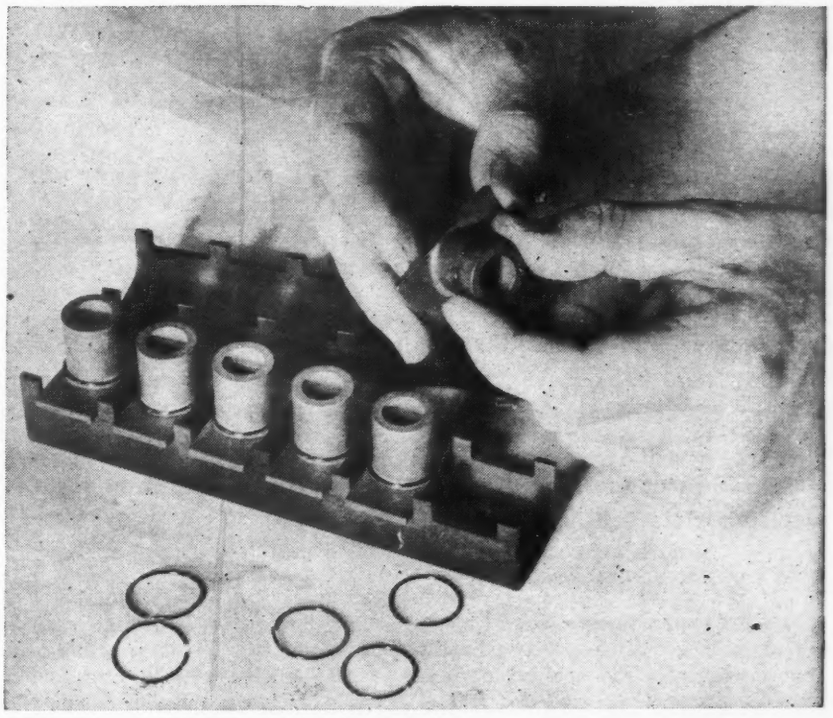


Fig. 5. Self-centering connecting rod bolts have 60-deg. seats under head and nut to prevent bending stresses being added to normal loading. Nut is splined for box wrench, instead of being hex. Reduced dia. of shank permits flexibility without reducing effective tensile strength below that at base of threads.

PLANT PRACTICE HIGHLIGHTS

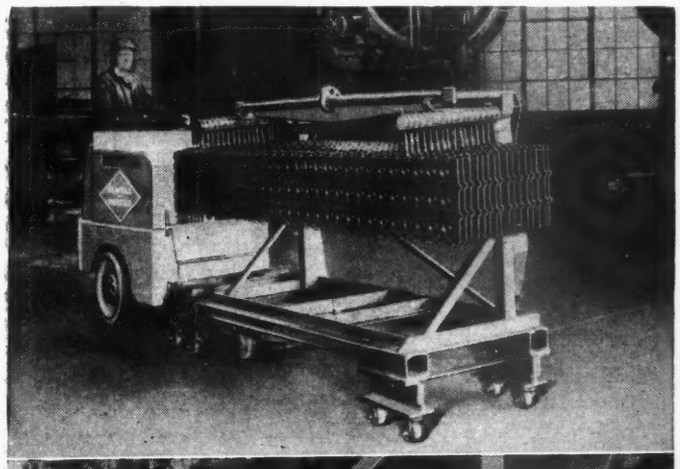
Brazing Fixture Saves 13c Per Part

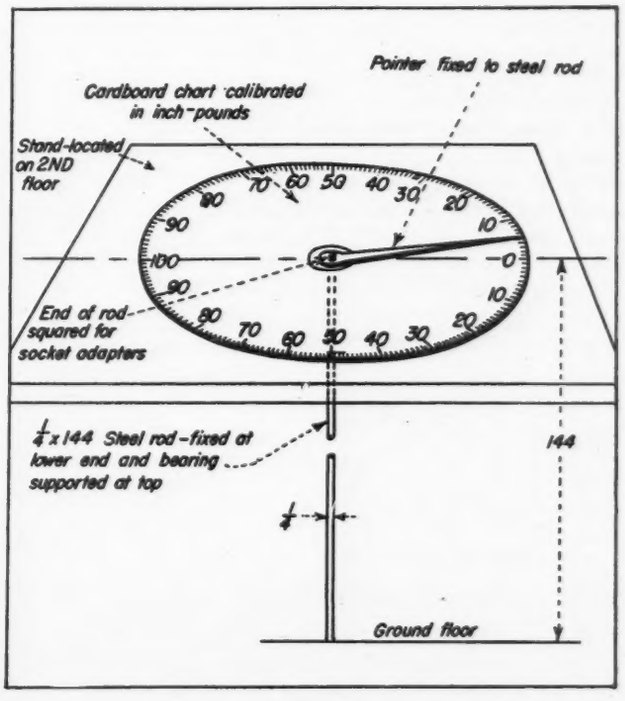
• Using steel tubing and strip in brazing fixture developed by tool design department, Glenn L. Martin saves 13c. per piece in fabricating cam followers, as compared to former method in which part was machined from solid bar stock. Brazing wire ring is slipped over tubular part of work before placing in electric furnace.



Auxiliary Dolly Handles Long Loads

• Faced with problem of moving long materials which could not be mounted crosswise on plant trucks, Elwell-Parker Co.'s Cleveland shops built this auxiliary truck to fit between tractor and load, permitting ends of material to overhang and maintain balance.




Pointer fixed to steel rod
Cardboard chart calibrated in inch-pounds
Stand-located on 2ND floor
End of rod squared for socket adapters
¼ x 144 Steel rod - fixed at lower end and bearing supported at top
144
Ground floor

Simple Torque Meter Cuts Error to 0.5%

• Convair's San Diego test lab invented this torque meter for measuring angular rotation due to twist, readings being shown on dial in in.-lb. Top end of rod is squared to accommodate ordinary socket wrench adapters. Since torsional moduli of rigidity vary for different steels, calibration must be done experimentally. A larger meter with capacity to 800 in.-lb. was made by using ½-in. dia. rod, instead of the ¼-in. rod shown in the diagram. Error is less than 0.5% in testing bolts, nuts, torque wrenches, and plastic specimens.

. . . WHEN JONES SAYS: "MY RADIO'S ON THE BLINK"

By WILLIAM A. BURROUGHS, III, *Aeronautical Radio Manufacturing Co.*

Extra dollars can be made by the small airport operator who is able to locate and remedy the simple, non-technical operational troubles in aircraft radio systems. And there's further "trade" and goodwill in being able to spot the deeper difficulties and conveniently get them corrected through an arrangement with a local radio repairman. This concise article tells how.

MANY OPERATORS of small airports are experiencing difficulties with radio servicing—a type of maintenance work which is merely routine at the large ports, where crews of trained technicians are on tap.

Employing little black boxes and such strange looking devices, technicians quickly check a plane's radio equipment and have it back in good shape, with no more trouble than it takes the small operator to diagnose and remedy some engine fault. Even so, the experienced aircraft mechanic—though not being able to afford the services of a special radio staff—can still count many a radio problem well solved and send a satisfied customer on wing just by remembering and following a few simple pointers on the seemingly mysterious subject of radio.

Basically, all aircraft radio systems consist (Fig. 1) of these items:

1. Receiver for receiving a signal.
2. Transmitter for sending out signal.
3. Antenna system for getting these signals from or into the air.
4. Headphones for getting the receiver's output to the ear.
5. Microphone for converting speech into an electrical quantity that the transmitter can handle.
6. Power for the receiver and transmitter.
7. Controls.

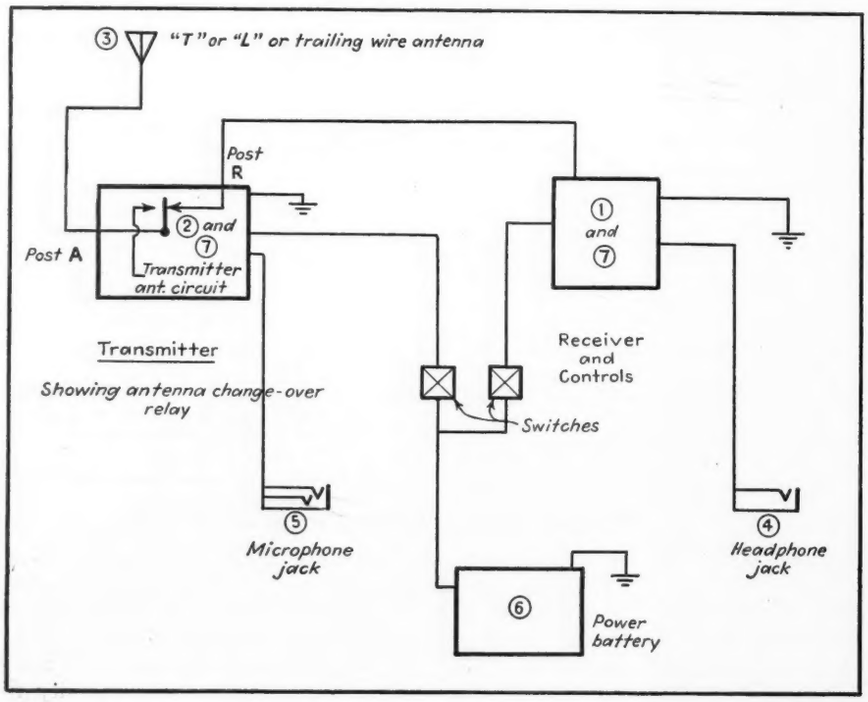


Fig. 1. Parts of aircraft radio, showing: (1) Receiver, (2) transmitter, (3) antenna lead-in, (4) headphone jack, (5) microphone jack, (6) battery or source of power, and (7) receiver and transmitter controls.

Your modern aircraft has its radio "station" neatly packaged and well distributed around the aircraft, the better to fit all the equipment in. Suffice it to say, it is rarely all in one spot. It is not uncommon to have to search before uncovering all of the parts; but if the equipment was working previously, it obviously must all be there somewhere, and hence can be located.

The antenna (Fig. 2) is a good place to start, because it is the jumping off and arriving point for the signals. There is variety in antenna design in order to fit specialized situations. The big problem on aircraft is getting the proper length of wire—a matter important in transmission—without encircling the craft and keeping the pilot from using the door.

Therefore the types of antenna mainly used are of the straight-wire form running from a short mast atop the cockpit to a point on the stabilizer, with a lead in wire dropping down either form (1) center, or (2) off one end. The former is called a "T" and the latter is termed an "L" antenna. These same types are used with short masts on the belly. There can also be the "V" form—a wire going from one wing tip aft to the stabilizer and back to the other wing tip. A lead-in wire is taken off at a spot along its length or in the center of the "V" at the stabilizer.

These are the main varieties of antenna, and they represent compromises between what is needed electrically and the size and type of aircraft. However, the design that comes closest to perfection is the trailing wire, with weight dropped through a fairlead in the belly

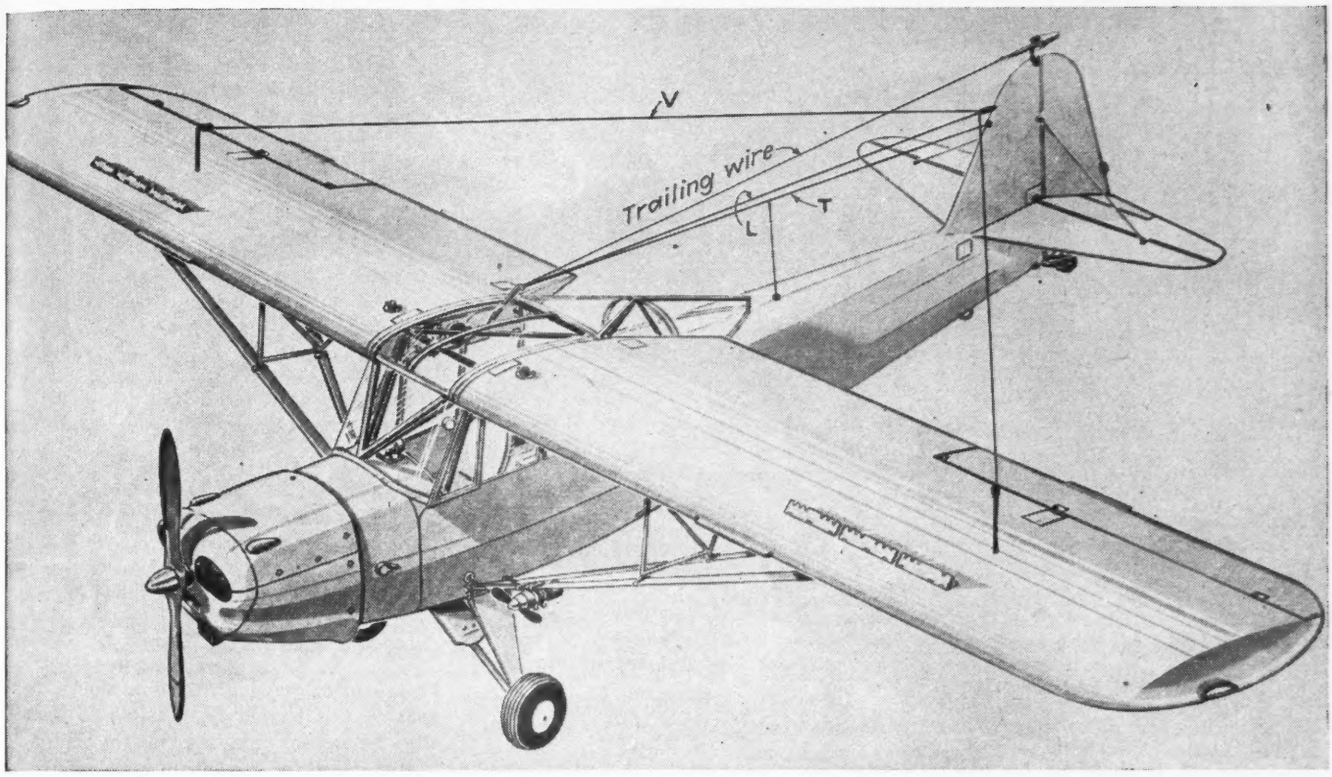


Fig. 2. Types of antennas used on small aircraft. "L" type has end lead-in; "T" antenna has center lead-in; "V" runs from wings to stabilizer, with lead-in from same point on each side, or at rear; and trailing wire with cone to provide tension, is reeled out through fairlead on top of vertical stabilizer.

from a reel (or from a reel through a fairlead on top) and through an insulator on the stabilizer to a wind cone, which assists in pulling the wire clear of the craft when the reel is released.

All of these antennas have one point in common: Sooner or later they reach the receiver and transmitter and anything that impedes or interferes with this end defeats their purpose. A ceramic insulator or lead-in bowl may look better painted a bright green or shiny aluminum, but they don't work so well as insulators. The signal coming or going decides to follow the path of least resistance, and that may be into the stabilizer or wing tip, which doesn't help raise the control tower.

So clean up those insulators and check for shorts to the craft along the path the wire follows. Look for breaks where the wire and lead-in join and where they enter the plane at the lead-in bowl. If you've got an "L" antenna and the lead-in has been broken, don't make a "T" by connecting it farther from the end than where it was originally connected just because the wire won't reach. Instead, put a new piece of wire in the same place and solder the joints. To change its length is to change something to which the transmitter will object to by lowered efficiency, even if the receiver doesn't show the difference. Remember the skilled boys with the black boxes aren't available to compensate for differences in the antenna structure.

From the antenna system outside the aircraft the wire is taken in through a lead-in bowl, except in the case of the trailing wire type, on which the lead-in is taken off the fairlead into the plane. The lead-in bowl is nothing more than two ceramic cups—one outside and one inside the plane and held together by a threaded brass rod. These should be checked to make sure the wire is securely lugged to the rod and that the lock washer and hex nuts are tight.

On the inside of the plane will be found an insulated wire running from the bowl. Check this for worn insulation where it passes over metal supports. If it contacts metal at any spot the transmitter will be inoperative and the receiver will be intermittent and noisy. Follow this wire to its terminus, which is usually on the transmitter. A frayed end touching the case can cause the same troubles just mentioned.

If the complaint is poor reception, follow the lead from the transmitter to the receiver. The change from transmitting on the antenna to receiving on the same antenna is accomplished by a relay in the transmitter which is always in a "receive" position and changes to "transmit" when the microphone button is depressed. Sometimes noisy reception can be traced to this relay—a failure in making good contact or its fluttering from vibration. The contacts can be cleaned (with carbon tet or crocus cloth) and a bit more tension given the hold-

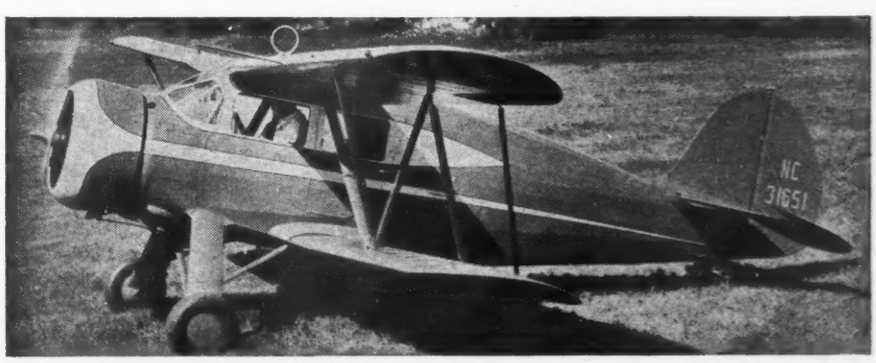


Fig. 3. Directional loop antenna can also be used with small radio receivers and is of great value when flying during darkness or in fog.

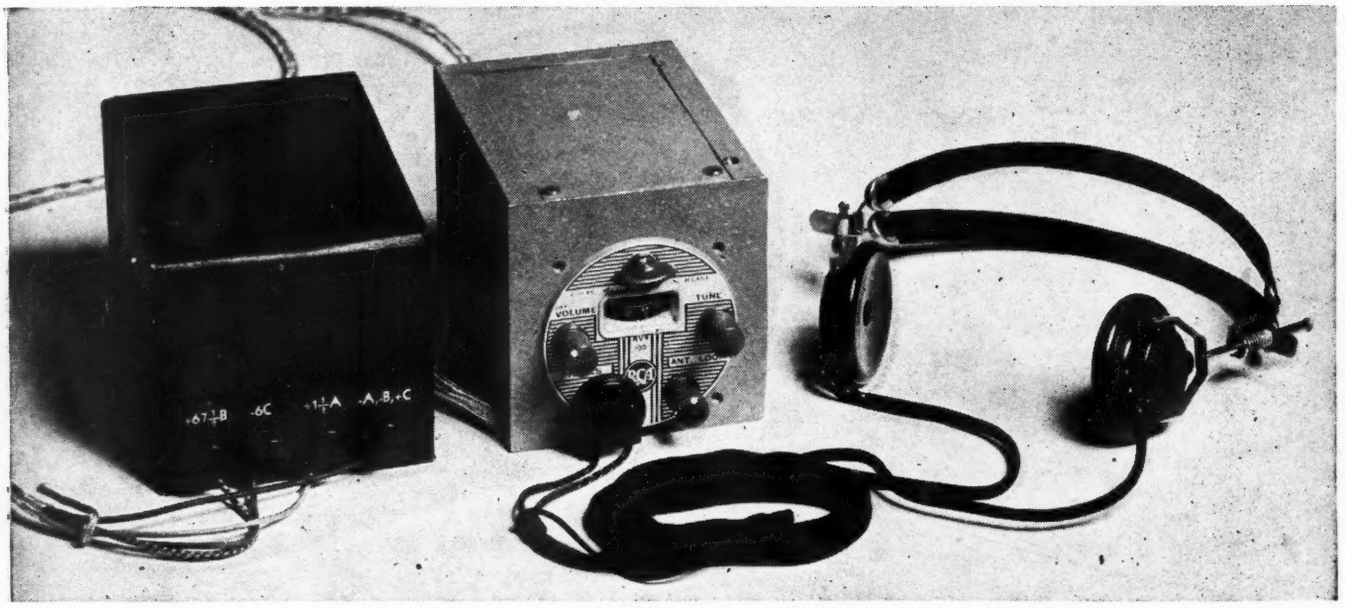


Fig. 4. RCA lightplane receiver with battery and headphones weighs only 8½ lb. and fits standard 3-in. AN instrument board opening. It receives on beacon, broadcast and traffic control tower frequencies by turning knob at top of dial.

ing spring, but don't overdo the tension and don't use a file on the contacts.

In the cockpit can be found other sources of receiver trouble. (It is assumed, of course, that the receiver tubes are lighted, that the plane's batteries are up to par, and that no plugs, cables, or fuses are out. The same thing applies to the transmitter when that is discussed. Headphones in the cockpit are possible weak links. The plug on the end of the connecting cord should be in good condition and must fit securely in the jack. This may sound trifling, but many cases of "dead" reception have been due to not having the headphones properly plugged in or the receiver volume control turned up enough.

Of course, the phones also can give trouble. Try using a pair known to be good or plug the ones in question into a receiver that is known to be operating. They can be checked, too, by connecting them across an ordinary flash light cell. A definite click will result if they are working..

So far, we have covered common receiver troubles. If the bad spot hasn't been found, it might be a defective tube —defective even though it lights. So each tube should be tested on a tube checker, and in taking them out watch that they are returned to the correct sockets and that they seat well. Other troubles with the receiver are beyond the scope of this paper and call for the attention of a regular radio technician.

Now assume a report is received of the transmitter not working. The batteries are "up," all plugs, cables, and fuses check, and the tubes light. If the tubes don't light when the switch is "on" it is power, switch, or cable trouble, or a batch of defective tubes (though this is unlikely). The receiver is known to be working, too. (There have been cases of pilots complaining of no answer to their transmissions and blaming the *transmitter* when they were not receiving. Having the *receiver* turned on helps a lot!)

Has another microphone been tried? The "mike" has its moments of weakness like headphones—bad cords or plugs. The best test is to try another. And, like the headphone plug, it should fit securely in the jack. These plugs can't be mixed up because they are of different types and will not fit the wrong jack, but they should be pushed all the way in. If the plug is left out only a scant eighth of an inch the whole transmitter will be no better than junk insofar as operation is concerned, because the control circuits are connected to, and operate by, grounding the tip of the plug when the microphone button is depressed.

The talking circuit is connected to a ring on this plug and the brass sleeve that comprises a major portion of it is common to both circuits and is connected to the ground when the plug is inserted in the jack. Importance of this plug and cord can readily be understood and should be viewed as a possible troublemaker when the pilot reports he couldn't raise the tower in the town he just passed.

If the microphone is known to be in good condition and properly plugged in, turn on the transmitter and depress the button after waiting a minute for it to heat up. It should be possible to hear the dynamotor running in the transmitter as long as the button is held down. If okay on this score, take a 0.25 w. neon bulb—obtainable in most electrical and radio supply houses—and, being careful not to touch the metal ferrule (a burn can result), contact it to the antenna post on the transmitter while someone operates the microphone button. It should glow, and when someone speaks or whistles in the microphone the glow should brighten slightly. If the tubes are lighted and the dynamotor is running and no glow results it can be assumed that the trouble demands a radio technician.

A word of caution at this point: The transmitter has fairly high voltages on inside circuits, so the inexperienced person will find it rather dangerous to work with the switch on. Its a delicate device and tampering can quickly misadjust it. Beside this, the FCC requires anyone operating a transmitter or making circuit adjustments to have the proper FCC license. A 3rd Class license or higher is required to operate and a 2nd Class or higher for making adjustments.

Noise has been defined as a jumble of unharmonious and annoying sounds. Unharmonious or not, noise in an aircraft radio receiver is not only annoying but can be dangerous to the safety of the craft and its passengers by preventing the proper reception of vital information. Such noise can be caused by a shorting antenna, faulty volume control, bad tubes, and many other things in the radio system, or by atmospheric conditions about which nothing can be done.

Move the plane into the open field

away from buildings and power lines. If the noise is still heard, try removing the antenna *at the post on the receiver.* The noise should cease if it is coming from outside the ship. Noise which is still present indicates trouble in the receiving system, which should be thoroughly checked. Check the receiver connecting plugs for presence of water, which causes electrolysis and a frying noise. Plug contacts should be bright and clean.

Another prolific source of noise is the aircraft engine. Have the antenna connected normally and the engine running. A rise and fall in noise when the engine is slowed or speeded up plainly indicates that the engine is causing the fault. Investigation of the ignition shielding should be made, checking for breaks and loose nuts. Defective plugs or magnetos are sometimes indicated by noise in the receiver.

Pay particular attention to bonding in the engine, on transmitter and receiver cases, and on other components of the radio system. Nothing is simpler than making a good electrical connection between a piece of metal and the frame of the plane, but volumes could be written about how poorly it is done in many installations. Therein lies the cause of much radio noise. A good bond should be short, and the point of contact at each end should be bright and a good mechanical, as well as good electrical, connection.

In cases of noise not previously present, it might be well to ascertain whether any work was done on the engine or any piece of gear added to the craft. Often it will be found that the bonding was never replaced. It's impossible to say whether a certain piece of bonding is removing noise so they must all be considered important and treated as such.

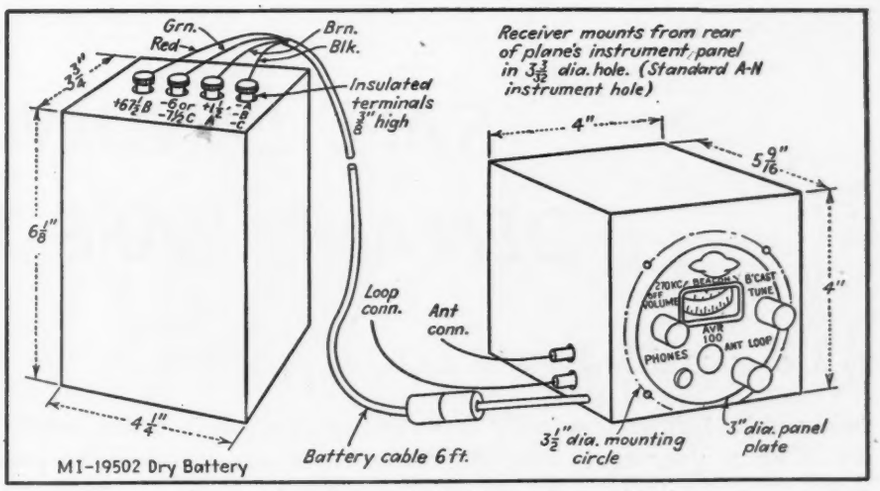


Fig. 5. Connections to light plane radios are simple and can be easily followed through when tracing trouble.

After the aforementioned checkups of the transmitter and receiver, a juncture is reached where it is neither practicable nor profitable to continue without the services of a radio technician. But such men are not hard to find, for even in the most remote spots there's usually a town boasting an able radio repairman who has a good knowledge of radio circuits, even though his primary work has been in home radio service.

The small airport operator doesn't have enough aircraft radio work to keep a man busy full time, but he can arrange repairs through such a local technician for mutual benefit. This radio repairman will have a tube checker and carry a stock of the commoner tubes and parts found in most receivers. So it might be worth while to talk over the situation with him and reach an agreement on units to be brought in for test and repair when the airport operator has exhausted all other avenues of locating the trouble.

In the course of this discussion, the major portions of an aircraft radio system have been covered and the more simple causes of complaint touched upon. Granted, the foregoing pointers will not make any small airport operator into a full-fledged radio technician, but it is hoped these tips will help him toward a better understanding and solving of some of his radio problems, thus aiding in getting his customers back on the beam.

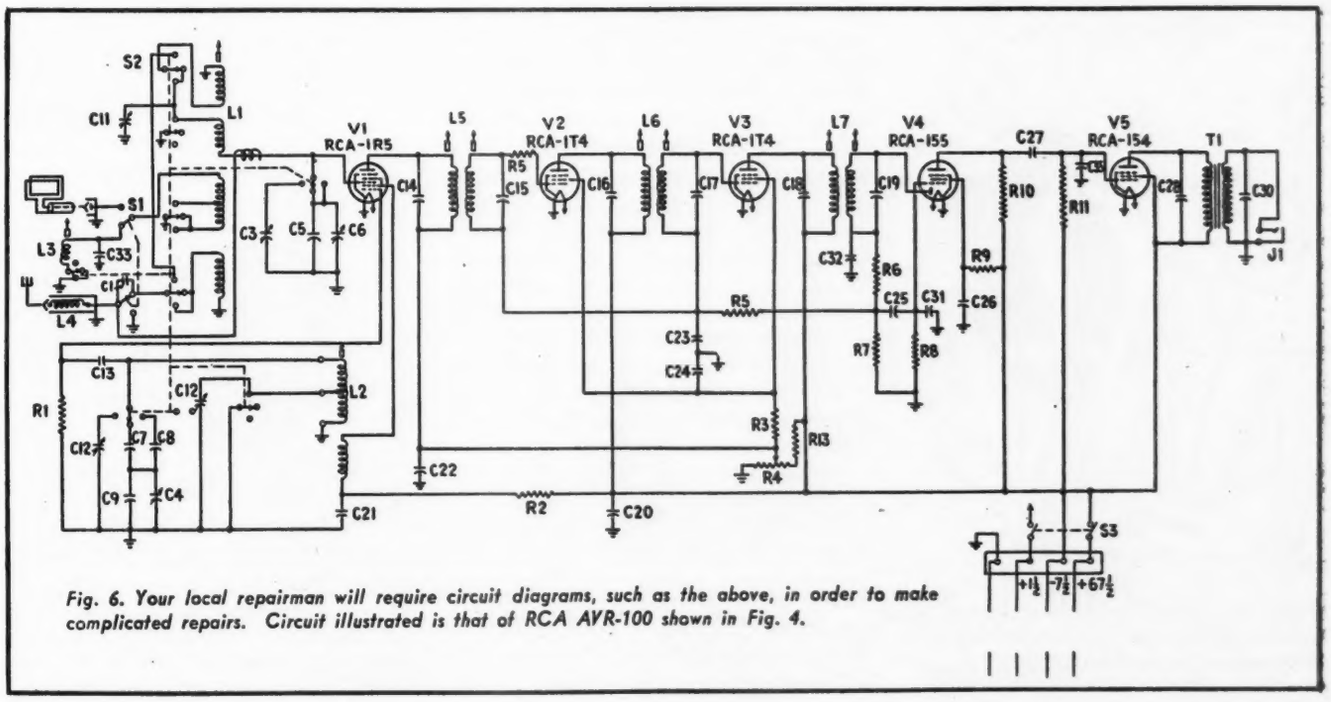


Fig. 6. Your local repairman will require circuit diagrams, such as the above, in order to make complicated repairs. Circuit illustrated is that of RCA AVR-100 shown in Fig. 4.

SAFE LANDINGS DEMAND SAFE TIRES

By **A. C. MARTIN,** *Sales Manager, U. S. Rubber Co., Aviation Tire Div.*

In every "set down", security depends upon the state of the rubber which eases your craft onto the runway. Proper maintenance procedure, as detailed here, will assure that your tires can "take it" now—and "take it"' the longest.

TO A VERY LARGE EXTENT, preventive maintenance of aircraft tires is synonymous with preventive maintenance insuring the pilot's personal security. This fact alone should be sufficient reason for exercising the greatest care in keeping your rubber in the best of condition, even if the attendant reduced cost of operation is not taken into account.

Preventive tire maintenance—or catching trouble before it catches you—may be divided into seven phases. Each of these calls for a simple routine which should be followed without deviation if best results are to be expected. The phases are: Care before mounting, mounting procedure, inflation, inspection during use, repair, cleanliness, and storage when not on the plane.

Before Mounting

Inside of casing should be inspected and cleaned out thoroughly, after which tubes must be examined to make sure they are in good condition.

When Mounting

Lubricate inside casing around beads with vegetable oil soap. Then mount, inflate, and finally deflate completely and re-inflate. Use proper tools carefully to avoid damage.

Care Before Mounting

After removing wrapping, which should always be kept on stored casings to prevent deterioration from strong light, inspect interior of casing for breaks in body cord, chafing near beads, and damage to treads through rough handling or poor storage.

If inside is in good condition, wipe out with a cloth moistened with solvent, dry thoroughly, and sprinkle talc freely over entire interior surface.

Inspect tubes for damage or signs of cracking through overly long storage. Check valves for condition and examine threads, running a nut or cap over them to assure free action. Stretch tube between hands to discover any damage caused by pinching, if it has been used before. While doing this, look for signs of punctures or surface cuts. If tube passes inspection, clean and dust with talcum.

Mounting Tires

First step in mounting tire is to lubricate the inside of the bead region with vegetable oil soap. On no account should grease be used.

The tube is then inserted in the casing and the assembly placed on the wheel. To insure proper seating of the tube, it should be inflated to full pressure and then completely deflated by removing the valve core. After this, the tire can be fully inflated, with the assurance that it will not be pinched or wrinkled.

Inflation and Checking Pressure

Air pressure in tires should be checked at least once a day, and after each flight if a number of landings have been made. Pressure should not be checked by using a gage unless rough field surface makes it impossible to use a deflection template. If a gage is used, it should be checked first against deflection pressure, measured on a flat surface such as planking or concrete. Nose wheel tires, however, may be gage-checked, since they do not carry a high percentage of the load when at rest.

It should be remembered that under- or over-inflation are prolific causes of

Watch That Pressure

On main tires, pressure should be checked daily with deflection template rather than pressure gage, which should only be used in emergencies. Incorrect pressure ruins tires fast.

skidding and premature wear. Neglect of the ordinary precaution of testing tire pressure may increase cost of landing considerably through rapid deterioration of the casing.

Inspection

Abnormal wear may be discovered at daily inspections if scissors links on shock absorbers do not function properly to prevent abnormal amount of shimmy. Misalignment through bending of landing gear parts will cause treads to wear fast. Loose axle nuts also cause similar trouble. Parts should be adjusted immediately, before takeoff.

If inspection shows that tires are wearing on one side only, casings should be reversed on the wheel to even up the wear and prolong tire life.

Replace immediately any tires which have deep cuts, exposed fabric, or embedded foreign matter. Leaky valves should be renewed as soon as discovered. Tires should always be paired up evenly.

Repairs — Are Important

Repairs should be made immediately after being discovered. Taking off with damaged tires is bad enough but the subsequent landing may be considerably worse.

Check the Worn Spots

Wear, caused by misalignment or loose landing gear partss, is a dangerous condition which should be remedied immediately.

Plain and non-skid treaded tires should never be used together—unless you like to ground loop when the brakes are applied.

Repairs

Avoid temporary repairs unless absolutely necessary. Have tires recapped before wear causes fabric to be visible. If temporary patches are applied in an emergency, have a permanent vulcanized repair job done before taking out the plane again—or, change the tire.

Cleanliness

Oil and grease are enemies of both natural and synthetic rubber, which are softened, becoming weak and subject to greatly increased wear. Oil or grease should be removed from tires by using gasoline and a cloth, afterward drying off the surface. Grease should never be used as a lubricant when replacing tires on wheels. The correct lubricant is vegetable soap.

Storage

Storage determines, to a large extent, the length of tire life that can be expected.

Casings should be wrapped in lightproof paper when kept in a room in which there is strong sunlight. If used for tire storage only, the windows of the storeroom may be painted blue. Air currents deposit considerable dust in casings which are not wrapped, thus interior cleaning is advisable before mounting. A cool, dry room, fitted with racks having rounded corners, is best for tire storage. If possible, rack tires as mounted units on wheels. Never stack casing flat.

Tubes should be stored flat in cartons. The latter should be laid flat—never on end because this position will cause the tubes to fall into one end of the carton, with resulting creases.

Proper Storage

Store tires in a cool, dark place where there is no dampness.

Everyone — Look Out for Oil

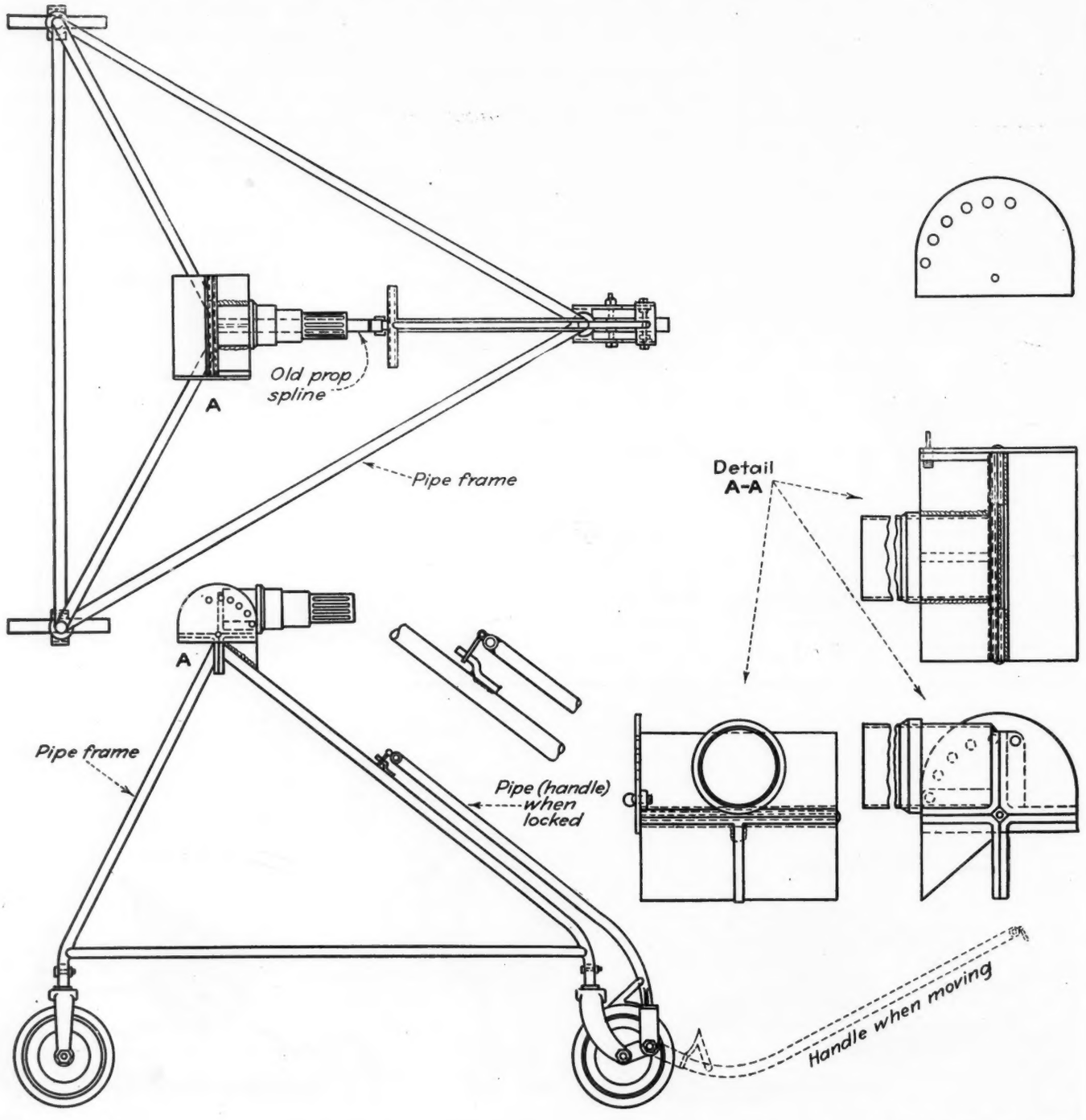
Never permit grease or oil to remain on the rubber. Remove with cloth moistened in gasoline and wipe dry.

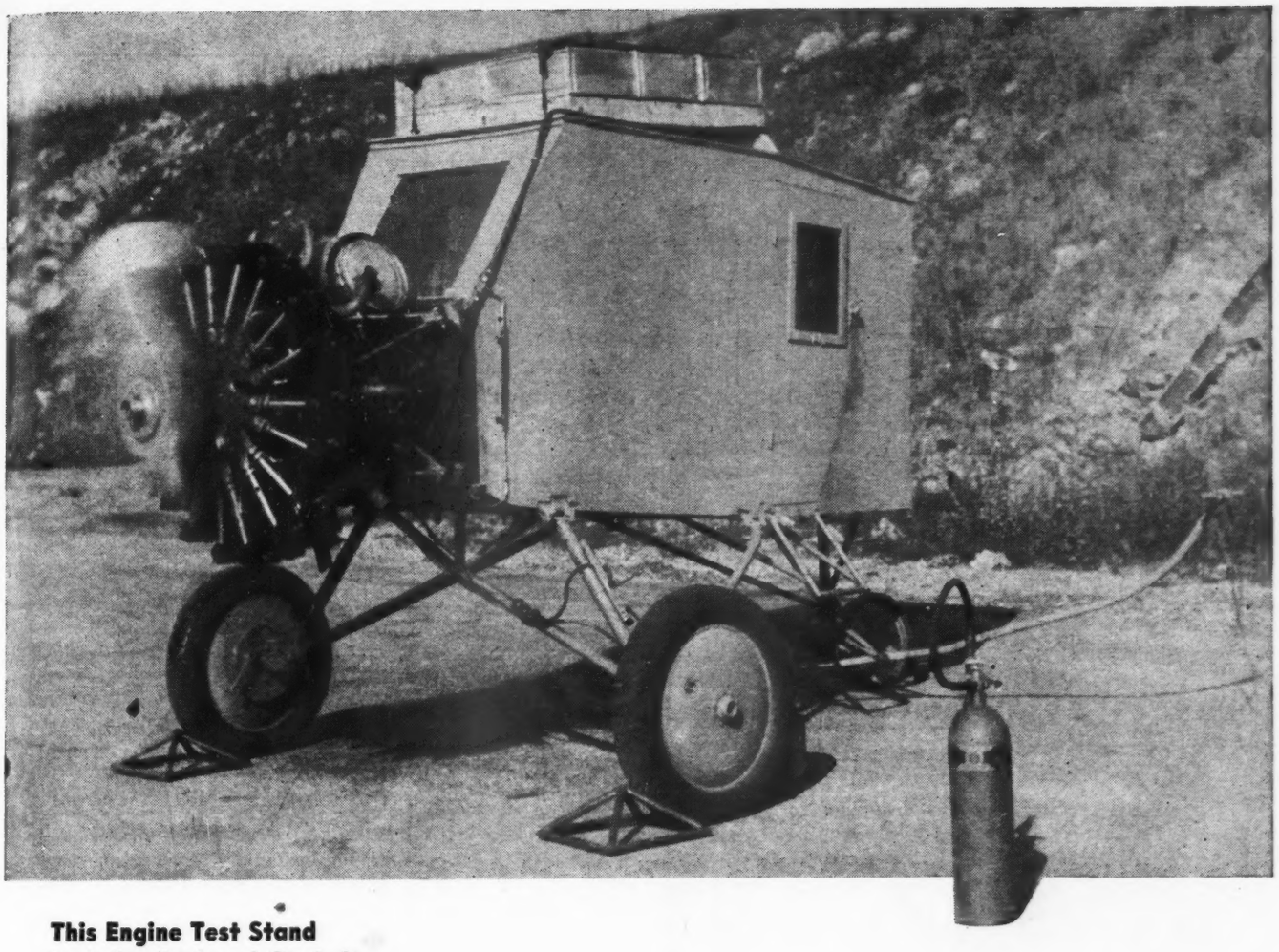
Prop Stand Has New Features

• Three-wheeled prop storage and handling stand is equipped with automatic brake, applied when handle is fastened against frame and released with handle when stand is being rolled across floor.

Propeller is mounted on spline from disused shaft, this mount being fitted with a hinge, enabling it to be locked by a pin in several positions between vertical and horizontal. Because spline prevents prop from turning, it is not necessary to fasten blades in place.

By pushing stand backward when moving into storage, back wheels swivel under frame, taking up no more room than that occupied by framework itself. Stand was designed and built at UAL's Cheyenne maintenance base as an improvement over older rigid types.

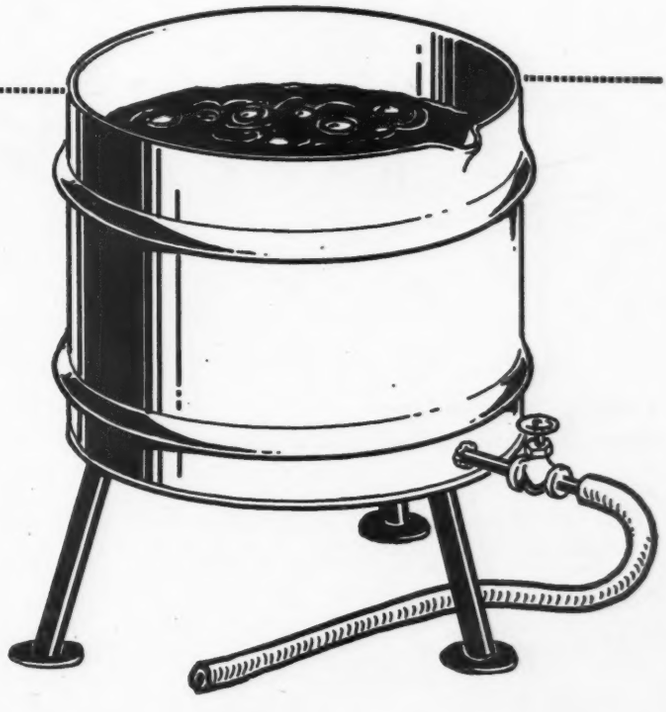




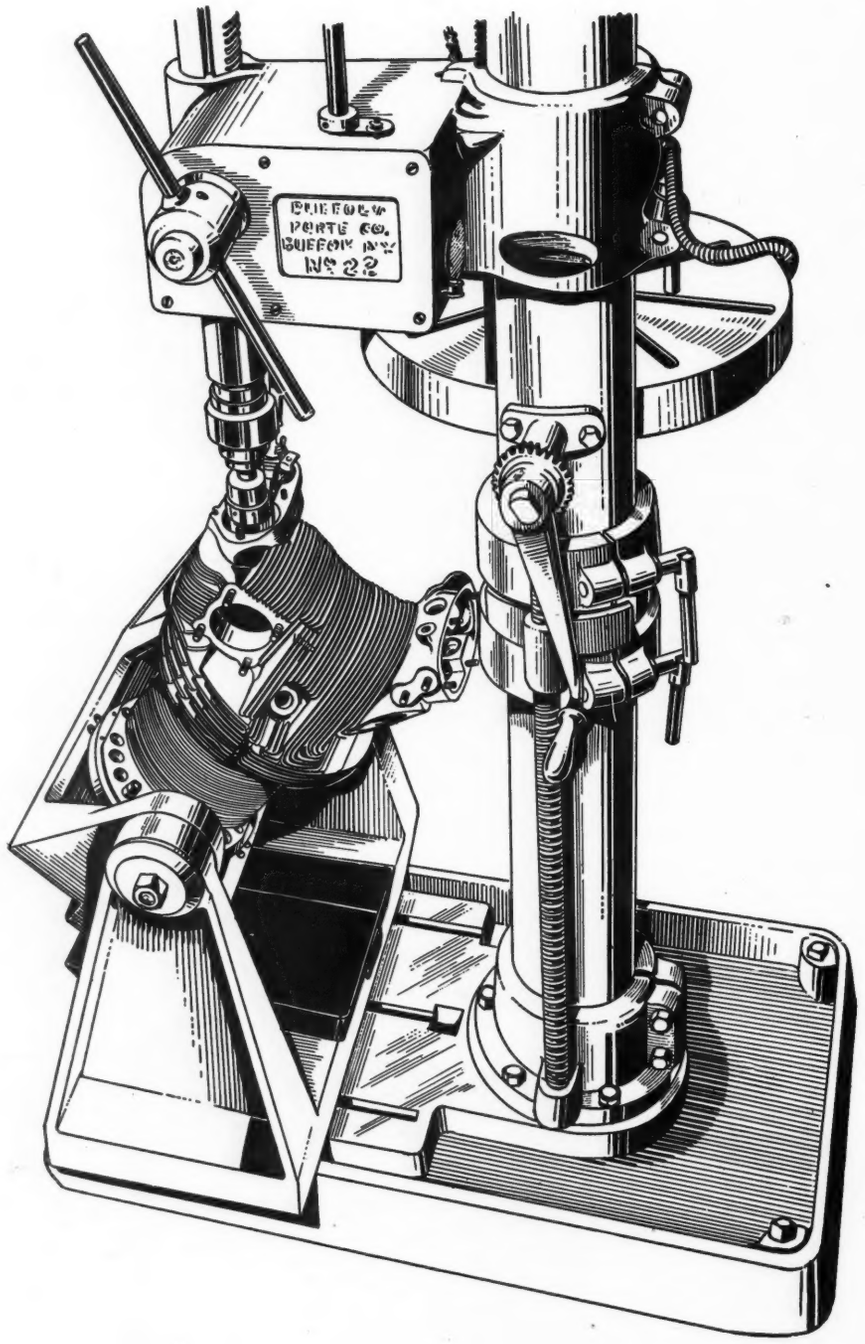
This Engine Test Stand Includes Enclosed Cockpit

• Built by All American Aviation's Pittsburgh shops, this outdoor engine test stand permits operator to handle check papers and controls while seated in shelter built and equipped like plane cockpit. Wheeled undercarriage enables operator to turn engine into wind for better cooling.

Simple Prop-Parts Washer Eliminates Bottleneck

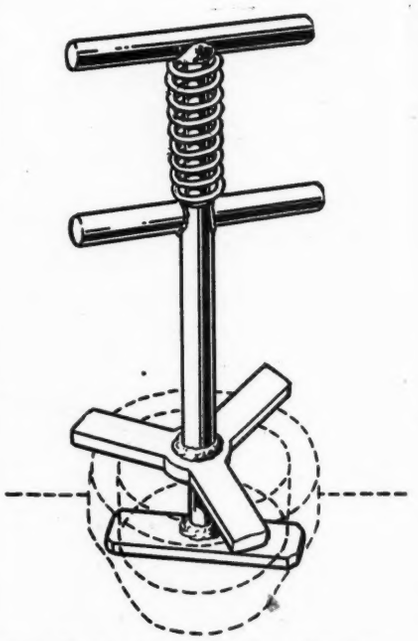


• Raising number of propellers washed per day from two to four, this shop-made washing unit has overcome AA's prop cleaning problems. Device is made from half an oil drum with a small air jet at bottom to agitate cleaning fluid. Unit, which requires no attention after filling, is invention of Lead Mechanic William Hunczak (above) of AA's propeller shop.



Rocking Cylinder Stand Improves Valve Grinding Accuracy

• Using a pivoted cylinder stand which locks with either valve seat in line with grinder centerline, EAL's engine overhaul shop has greatly improved both accuracy and speed of valve seat finishing.



Handhole Castings Positioned By Simple Clamp Device

• Here is a spring-operated clamp which has many applications in aircraft maintenance. Because pressure is applied by spring, effects of heat and of over-tightening are entirely avoided. C. Borreson of Douglas Aircraft invented device.

Hinged Rudder Bench Gives Access to Both Sides

• A carpenter's trestle, fitted with hinges for holding lightplane rudders enables Otto Aviation's Blairstown base to complete both sides of the part without taking from stand. Rudder horns prevent work from falling against legs.

Pilots: Know the Knack Of Survival After Force-Down*

1ST. LT. EDWIN W. ZOLNIER took off from El Centro Field at 0800 on 17 May, 1944, in a Goodyear FG-1 Corsair in a four plane division on a routine training navigation hop, to cover the area El Centro to Phoenix to Tucson to Phoenix to El Centro. When approximately one hour from El Centro, he noticed an excessive engine vibration, which increased until he realized that the plane could continue its flight for only a short time. Lt. Zolnier asked the division leader for instructions and was ordered to bail out. He then put the plane in a smooth bank and again checked all instruments, only to find them normal.

However, when the plane went into its turn, the pilot noticed the cockpit filling with black and white smoke which appeared to stream from under the engine cowling, and which carried a heavy odor of ammonia. Without further ado, he jettisoned the cockpit hood and bailed out from an altitude of 5,000 ft. indicated.

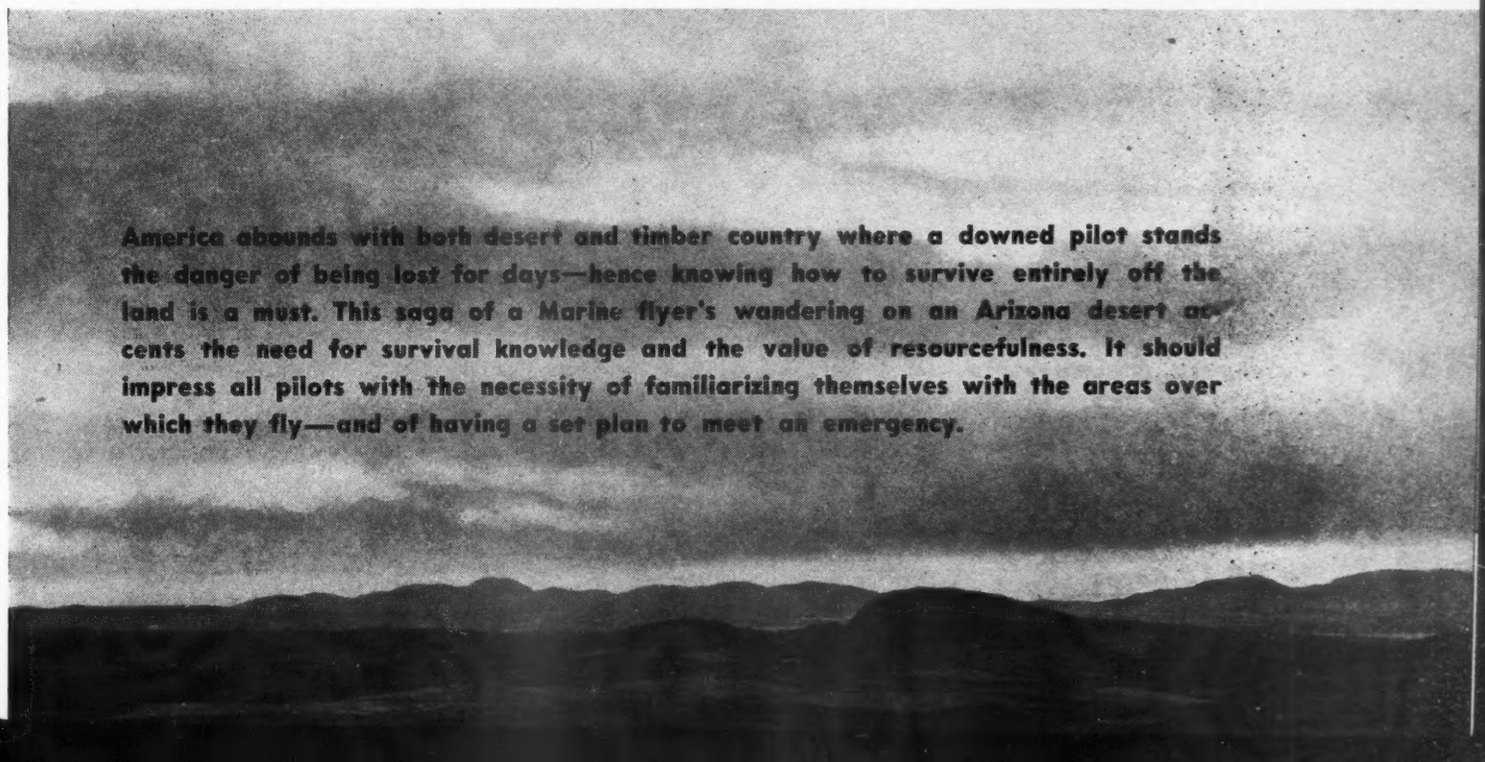
During the descent, Lt. Zolnier tried to get his bearings, but due to surrounding mountain ranges was unable to see anything other than desert and hills. Immediately upon a safe landing, Lt. Zolnier took stock of himself and possessions which included: Undershirt; drawers (white cotton); flying suit; medium leather helmet; goggles; headset (radio) and cord; field shoes and wool socks (both government issue); flying gloves; a wrist watch; and a Rosary. After spreading his parachute on the ground, Lt. Zolnier set out in search of his wrecked plane in hopes of obtaining enough fire from the smoking remains with which to build a signal fire to aid the rescuers. Reaching the scene of the crash, which was approximately three-fourths of a mile from his parachute, he found only a few cold charred pieces of metal of no value whatever. The pilot then attempted to return to his parachute, but was unable to locate it.

Maj. Reinburg, the commanding officer of Lt. Zolnier's squadron, who had taken off from El Centro 30 min. after Lt. Zolnier's flight, to fly the same course, approached the scene of the parachute jump, as the result of a radio call from Lt. Hauser. After searching the area, Maj. Reinburg finally located Lt. Zolnier and dropped a map of the area marked with Zolnier's position, and a note on the reverse side telling the pilot to remain with his parachute and a liaison plane would rescue him.

After further searching for his parachute, Lt. Zolnier remembered that he had flown over a populated valley so he walked in a northeast direction and climbed a high knoll to see if he was near this civilized area. Upon reaching the top he could see only desert. Descending, he saw a liaison plane on the ground near his parachute. Lt. Zolnier started running towards the plane, but when only a short distance from it, he saw the pilot climb in and take off.

After wandering around in search of water for a little over an hour, he scratched his initials in a large circle

* This pointed account—retaining the original Service phraseology—is taken from an official report by Intelligence, Marine Base Defense Aircraft Group 43, Marine Fleet Air, West Coast, USMC Air Station, El Centro, Calif.



America abounds with both desert and timber country where a downed pilot stands the danger of being lost for days—hence knowing how to survive entirely off the land is a must. This saga of a Marine flyer's wandering on an Arizona desert accents the need for survival knowledge and the value of resourcefulness. It should impress all pilots with the necessity of familiarizing themselves with the areas over which they fly—and of having a set plan to meet an emergency.

"Don't," emphasizes the experienced Lt. Zolnier, "leave the spot of initial landing." Argument is that wreck pinpoints your location for rescuers. Furthermore, parts may be used for fuel, shelter and signalling purposes.

approximately 30 ft. dia., which he thought would be easily discernible from an altitude, since the surface of the ground was black with a white undersurface, and he then sat down to await rescue.

However, after waiting several hours at the ground markings, Lt. Zolnier decided that he would go out in search of aid. Before his departure, he wrote a note on the back of a piece of the map saying that he was heading in a southwesterly direction in search of help; and attaching this to his radio headset and cord, he deposited these on his ground signal.

Remembering a training film, *The Castaway,* which he had seen only a few days previously, he began concentrating upon survival. He buttoned his flight suit closely around his neck, donned his helmet and gloves, and began his march toward the Colorado River. Lt. Zolnier thought that it seemed foolish that he should button his clothes up around the neck and wear his gloves when it was so hot, but that had been the way the training film had instructed, so there must be a reason. After hiking until after darkness, he became tired and decided to sleep for a few hours. He outlined a bed with boulders and filled in the center space with twigs and brush and lay down to sleep, with a stone on one side and a staff on the other as his only weapons against intruders. Thus his first day on the desert had passed, and he had felt no excess thirst or hunger.

Following Lt. Zolnier's parachute jump, Lt. Col. Stacy, operations officer of MBDAG-43, was telephoned by the duty officer of Datelan Field, and immediately dispatched a liaison plane piloted by Lt. B. L. Williams.

Lt. Williams landed near the pilot's parachute, but because of the rough terrain, blew out a tire. As Lt. Zolnier was not with the parachute, Lt. Williams walked over to the crashed FG-1, and was still unable to find the missing pilot. In searching the area around the crash, Williams found one of the FG-1's gas tanks from which he took the self-sealing rubber; and with this material packed his plane's flat tire, thus making a take-off possible.

Lt. Williams contacted the Sheriff of Yuma County, and asked for a ground searching party to be sent out the following morning. The sheriff, who was most cooperative, organized a party of Indian trackers, and with two jeeps and an ambulance, began the job of tracing the lost pilot early the morning of the 18th.

Waking from a few hours of restful sleep, at approximately 0300 18 May, Lt. Zolnier began to experience his first discomforts from thirst. After resting until the sky began to lighten, he once more began his journey. In preparation for the hike, he secured a small barrel-like cactus and after puncturing the top with a rock, he drank the water from the inside, which surprised him by its quantity and ability to quench his thirst. After chewing for a time on the pulpy, moist insides of the cactus, he broke open a second one to provide water for the day; this was stored for future use in the previously-ripped-out inside chest pocket of his flying suit, which he carried as a pouch and found invaluable throughout the journey. Lt. Zolnier found that by chewing continuously on the moist cactus pulp he felt little discomfort from either hunger or thirst.

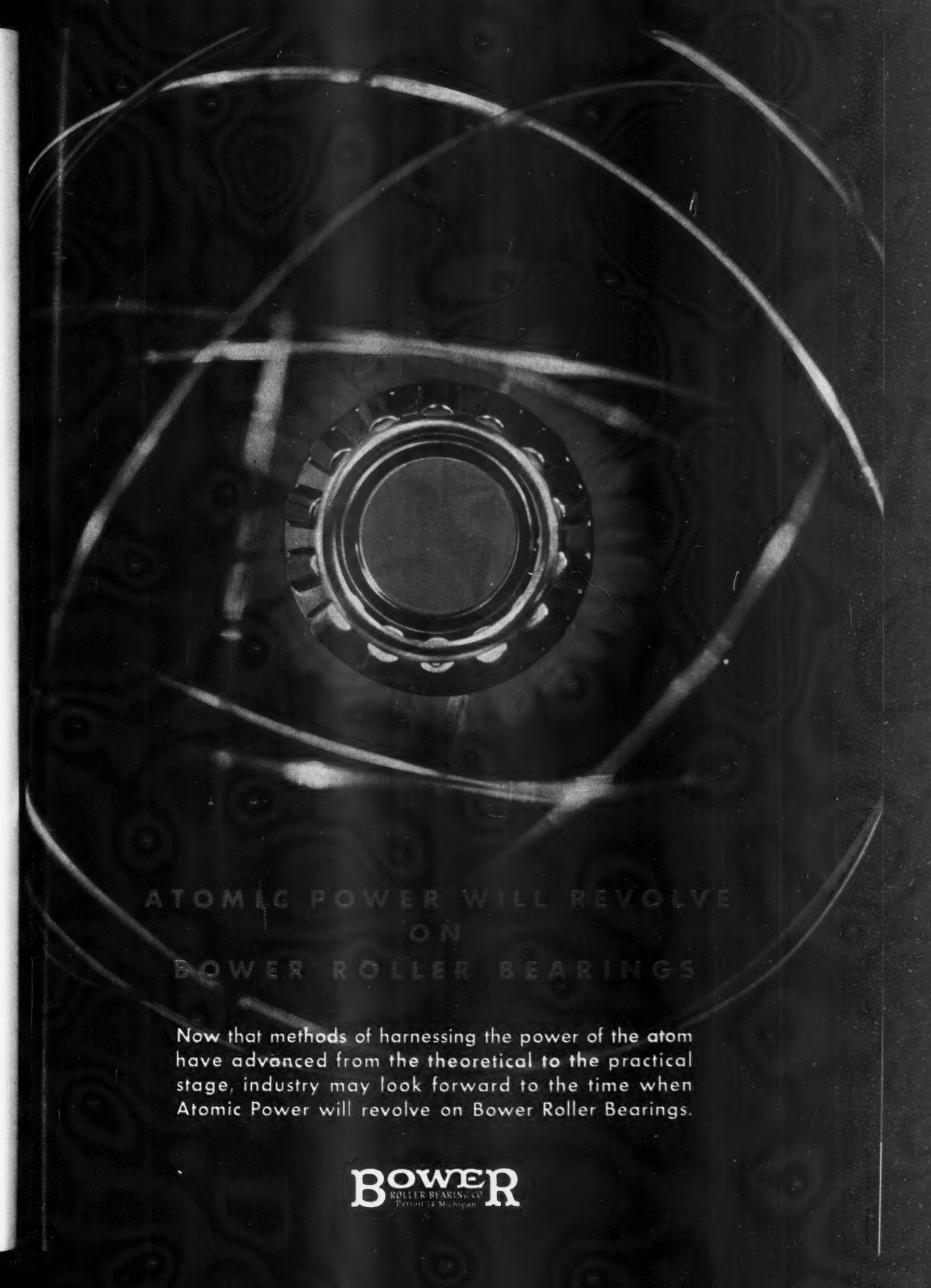
Lt. Zolnier could see planes searching the area, but he was unable to attract their attention. He found an empty Army C-ration tin container and polished the bottom of the can with sand and his flying suit. When signalling with this proved unsuccessful, he took off his white undershirt and shorts and waved them at the planes overhead, but this also failed and the white cotton soon turned black with the desert dust. The desert heat increased until Zolnier decided it was too hot to travel, so he found a shady spot under some desert shrub and removed all of his clothing. He then soothed his feet by applying cactus pulp to them.

It once more occurred to him that if he could only start a fire, rescue would be imminent. He made a pile of dry grass and tried to focus the sun's rays with his goggles, but as the glass had no magnifying power, this was unsuccessful. Next he tried striking two stones together but this also failed. Then followed rubbing two sticks together; also unsuccessful. Next he tried making a bow with his shoestring and tried the bow and socket method; but after a short time the shoestring was wearing thin, and rather than chance breaking it he also gave up this method. He next turned to his watch crystal—made of unbreakable celluloid composition—but this, too, failed to focus the sun's rays.

Feeling thirsty he went out to find more cactus juice. This time he experimented with a tall spindley cactus. He kicked a hole in its base and set his C-ration tin inside to collect the dripping juice. Upon trying to drink this juice it made him retch, so he gave this up. Removing the large buckle from his flying suit, he sharpened its edge on a stone and found he had a usable knife with which he sliced the top from another barrel cactus and obtained more juice and pulp. This juice, pulp, and the root of the barrel cactus (which tastes like celery) became Zolnier's staple nourishment for the remainder of the trip. He also attempted to eat several types of green leaves and roots, but they were all too dry to be palatable.

After resting through the heat of noonday, Lt. Zolnier continued his journey until a few hours after sundown. Find-

(*turn to page* 182)



Now that methods of harnessing the power of the atom have advanced from the theoretical to the practical stage, industry may look forward to the time when Atomic Power will revolve on Bower Roller Bearings.

BOWER
ROLLER BEARING CO
Detroit 14 Michigan

SINCLAIR POWER for WINGS to MEXICO

Flagship stop between San Antonio and Mexico City. Sinclair Aviation Gasoline is taken on at San Antonio.

As one of the major suppliers of fuel to Army and Navy Air Squadrons, Sinclair is proud to have introduced its aviation gasoline to commercial flying in planes of America's greatest air transportation company — American Airlines.

Sinclair Aviation Gasoline is *powering,* Sinclair Pennsylvania Motor Oil is *lubricating* American Airlines Flagships on their daily flights from San Antonio, Texas, into Mexico. Thus Sinclair-powered flight is now added to the hundreds of millions of miles of Sinclair-lubricated flight by American's Flagships.

Sinclair Aviation Gasoline will aid advancement of transportation on national and international airways.

SINCLAIR AVIATION OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

MOBILE DUAL REFUELER AFFORDS HIGH-RATE SERVICE

By THOMAS H. McCONNELL, Jr.
Intava Inc.

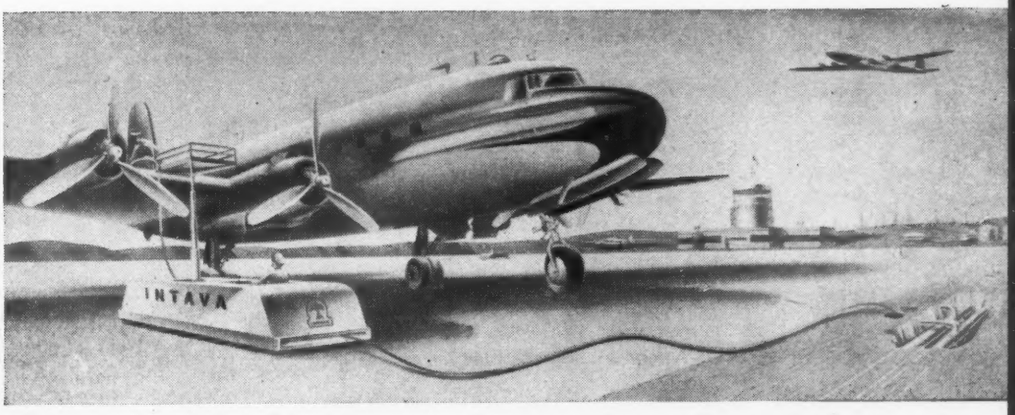
Designed to sharply cut fueling time on craft with large tank capacity, this twin-pump unit with integral prime mover transfers 150 gal. per min. per hose from feedline, also lifts personnel to wing level.

EQUIPMENT USED FOR REFUELING aircraft at the outbreak of World War II was geared to the demands of planes approximately the size of the Douglas DC-3 and could deliver about 50 gal. per min. from pits or refueling trucks. At this filling rate, refueling of larger craft, such as the Lockheed C-69 Constellation or Douglas C-54 Skymaster —having fuel capacities as high as 6,000 gal.—would require about 2 hr. with a single hose, excluding time required for preparations by the refueling crew.

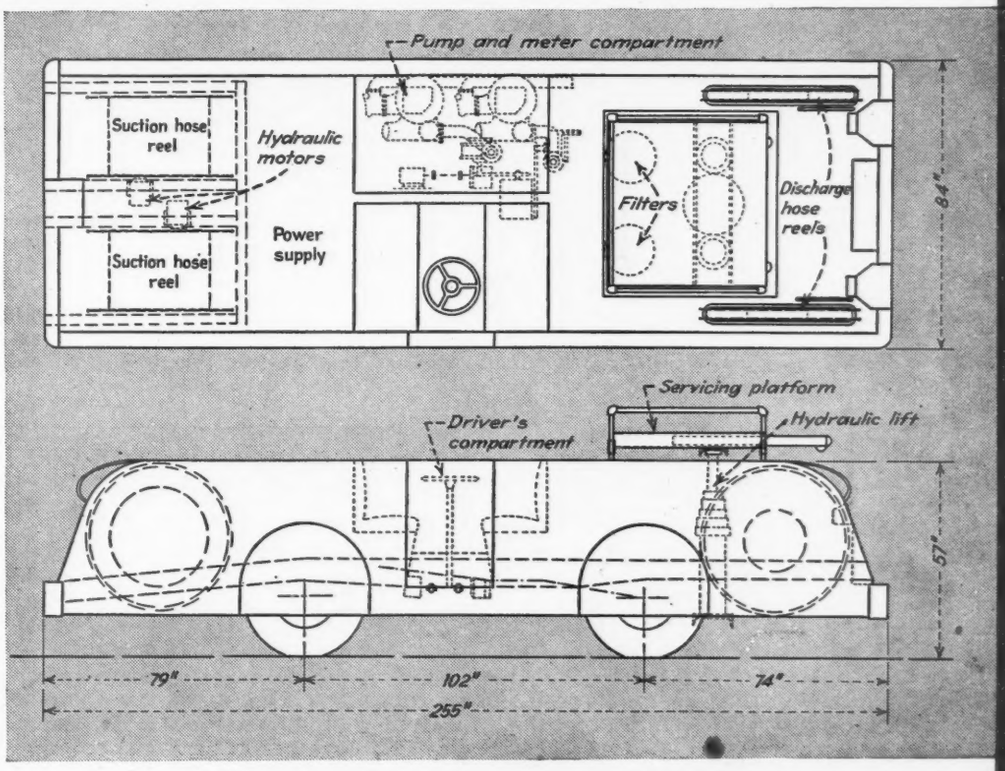
The Intava Servicer—a self-propelled refueling unit—is intended to eliminate (1) the disadvantage occasioned in servicing only a single large craft at one time and (2) necessity of returning the unit to a central filling station to take on additional fuel, as in the case of a refueling truck having a capacity less than that of the craft being serviced.

Designed by J. E. Knight, Intava Inc. equipment engineer, the Servicer contains two complete pumping systems, with air eliminators, strainers, meters, and filters. The unit has no storage capacity but obtains fuel via a 100-ft. suction hose connected to conveniently located hydrant valves in a system of underground piping, the hose being wound on a reel fitted with self-leveling rewind device and hydraulic rewind motor. Discharge hoses—40 ft. long and of 2-in. dia.—are also accommodated on reels, and each hose is capable of trans-

(*Turn to page* 190)



This artist's sketch of refueling operation on large aircraft shows utility of Intava Servicer—mobile unit equipped with 100-ft. suction hose for attachment to hydrant of underground feedline and incorporating two pumping systems each with discharge hose capable of transferring 150 gal. per min. Unit's telescopic lift has 4-ft. platform and is extensible to 15 ft. (W. W. Hennessy picture)



Features of Servicer are depicted here in plan and elevation.

TAGGING THE BASES

State Pilot-Registration Plan Seen Hobbling Flying

With nationwide protest against CAR 42 now seemingly jelled as successful opposition, the airport operator and personal plane owner are now finding another contingency in the proposed Model State Aeronautical Department Act, now being revised by a joint committee of CAA, NASAO, and the U.S. Department of Justice. Though most of the Model Act provisions—too many to cover in this restricted space—have been approved by the entire committee as helpful to aviation, NAA reports that the matter of state registration and licensing of pilots is far from being settled.

On the one hand, state officials (NASAO) contend that they should have power to register (and, by inference, cancel) CAA licenses of pilots resident in their states; while, on the other hand, CAA contends, with legal backing, that this state right would compel a system of separate registration in every state in which a pilot might land—a hardship not imposed on motorists or yachtsmen who enjoy unrestricted interstate travel. This proposal is also expressly forbidden by both Air Commerce Act of 1926 and Civil Aeronautics Act of 1938, now in force.

Free Tour Fuel. Gulf agents will supply fuel and oil gratis at following fields for airmen in Annual Light Airplane Tour to Florida Dec. 26 to Jan. 20: *Route 1:* Roosevelt Fd., N. Y.; Wings Fd., Ambler, Pa.; Cub Haven, Lock Haven, Pa.; Taylor Airport, New Kingston, Pa.; Schrom's Airport, Greenbelt, Md.; Central Airport, Richmond, Va.; Tarboro Airport, N. C.; Fayetteville Airport, N. C.; Smith-Reynolds Airport, Winston-Salem, N. C.; Cannon Airport, Charlotte, N. C.; Woodward Airport, Camden, S. C.; Jennings Airport, Orangeburg, S. C.; Ridgeland Airport, S. C.; Wilmington Island Airport, Savannah, Ga.; Hart Fd., Jacksonville, Fla.; Orlando Municipal Airport, Fla.; Whitted Airport, St. Petersburg, Fla.; Ft. Pierce Airport, Fla.; Lantana Airport, Palm Beach, Fla.; and Master Airport, Miami, Fla. *Route 2:* Municipal Airport, Cleveland; Port Bucyrus, O.; Springfield Airport, O.; Lunken Airport, Cincinnati; Capital City Airport, Lansing, Mich.; Niles Airport, Mich.; South Kokomo Airport, Ind.; Shank Airport, Indianapolis; Bowman Fd., Louisville; Bowling Green Airport, Ky.; Gillespie Airport, Nashville; Chattanooga Airport, Tenn.; Atlanta Municipal Airport, Ga.; Smart Airport, Macon; Albany Airport, Ga.; Wheeler Airport, Tallahassee, Fla.; Stengel Airport, Gainesville, Fla., and thence over fields designated for Route 1. *Route 3:* Midwest Airport, Ft. Worth; Mustang, Hudson, Lou Foote, Skyline, Victory, Whiterock, and Clearview Airports, all at Dallas, Tex.; Marshall Municipal Airport, Tex.; Shreveport Municipal Airport, La.; Wilson Fd., Memphis; Cone Airport, Tupelo, Miss.; Central Park Airport, Birmingham; Turner Fd., Monroe, La.; Jackson Municipal Airport, Miss.; Key Fd., Meridian, Miss.; Bridge Fd., Montgomery, Ala., and thence to Albany, Ga., and over Route 2. *Route 4:* Austin Municipal Airport, Tex.; Easterwood Airport, Bryan; Houston Municipal Airport; Beaumont Municipal Airport, Tex.; Girard Fd., Lafayette, La.; Bogalusa Airport, La.; New Orleans Municipal Airport; Bates Fd., Mobile; De-Funiak Springs Airport, Fla., and thence over Route 3 from Wheeler Airport, Tallahassee, Fla.

First Region—T. E. Frantz has purchased Garner-Hunter Aviation of Roanoke, Va., for use as flight school and repair base. . . . Scholter Aviation Co., operating Pittsburgh-Butler, Pa., Airport, now has "one stop" service comprising all services up to Magnafluxing and parachute repairs. There is a hotel on field and runways enough to avoid cross-wind landings. For 1-hp. travelers, there is a riding academy in connection. . . . Zahn Airfield, Amityville, N. Y., has just soloed 200th post-CPTP student. Steve Pinkosky, manager, now has agencies for Shell Oil, Goodyear and Firestone tires, Stinson, Piper and Republic Seabee planes. . . . Wiley Post, Jr., flew in a new Taylorcraft at 108 mph. groundspeed between Alliance, O., and Allentown-Bethlehem Airport. Lehigh Aircraft, managed by Post, gives free flight lessons to Taylorcraft customers. . . . Stressing the social side, Marty Green of Bristol, Pa., recently ran breakfast flights to Martin's Creek and to Red Bank, N. J. . . . Aircrafters, Inc., of Rehoboth Beach, Piper agent, has dormitory facilities for itinerant flyers and passengers of Maryland Airlines coming from Wilmington and Baltimore. . . . Beacon, Hybla Valley, Hyde, Congressional, and Riverdale airports report that courtesy tiedowns it provided for visitors to Joint Private Flying Conference in Washington were patronized by flyers from 41 states. . . . Wheeling, W. Va., Seaplane Base, Republic Seabee and Piper agent, has soloed a total of 91 students in its first four months of operation.

Second Region—Owens Fd., Columbia, S. C., will be used by both Hawthorne Flying Service and Dixie Aviation Co. . . . Harmon Walker and Arthur Porter have opened Porter-Walker Flying Service at Valdosta Municipal Airport, Ga. South Georgia Flying Service is also at this field. . . . Davis Aviation, owned by Ted, Ferd, and Barrie S. Davis at Zebulon, N. C., is Piper agent for Zebulon and Wake counties. The flying Brothers F. and B. S. Davis brought back 14 war decorations and medals, with 17 clusters, 9 stars, and 1 Purple Heart. . . . Aberdeen, N. C., Airport, recently opened, has completed two 2,500 ft. runways. . . . Hawthorne Flying Service Manager Walter Phipps reports that Thursday night "bull sessions" at Columbia Municipal Airport, S. C., are attracting non-flyers as well as many local pilots and have become an informal ground school. . . . Davis-Paxon, Atlanta's largest department store, is now Ercoupe agent.

Third Region—Michigan ATA, meeting at Dearborn Inn, expressed unanimous opposition to new CAR 42. . . . Harrington Air Service, of Mansfield and Cleveland, O., is now handling Beech, Republic Seabee, Lear radio, Romec pumps, Firestone products, and Strand steel hangars. "Mac" Goodwin, formerly with Taylorcraft, is now general sales mgr. . . . Noblesville, Ind., Flying Service, operated by R. E. Wise, is laying a concrete landing strip. Hangars and manager's house are also under construction. . . . Parks Air College, East St. Louis, Ill., Ercoupe and Bendix distributor, states that name of field has been changed from Curtiss-Parks to Parks Metropolitan Airport. . . . Prince Aviation Co., Detroit City Airport, has taken delivery of 6 new Aeroncas. . . . Thomas H. Noonan and Witham Smith are starting a seaplane base near the Town Yacht Club, Cincinnati. . . . O. C. Hall, of Northern Air Service, Kent County Airport, Mich., is making a survey of Grand River as a base for seaplanes. Assisting is Irving T. Woodams, of Austin Lake, Mich., Seaplane Base.

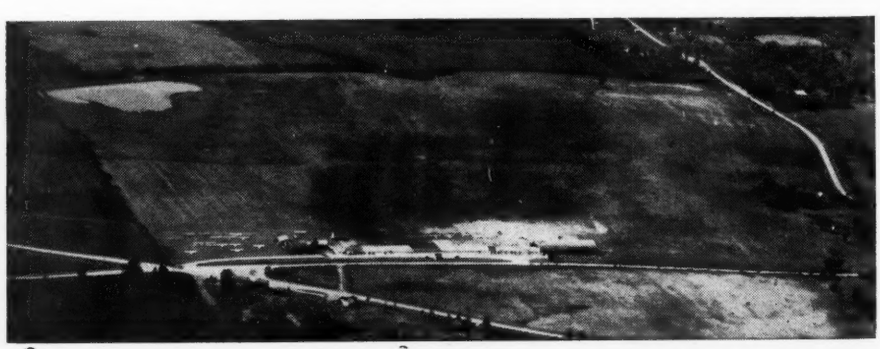
Fourth Region—E. R. Durham and G. C. Green of Tulsa, Okla., operating D-G Aviation Sales Co., have Taylorcraft agency for Tulsa, Osage, Creek, and Okmulgee counties.

Fifth Region—Fairhaven Ferry Service, White Bear Lake, Minn., operated by Joseph G. Rose, is running a feeder service to North Woods communities, flying an ex-Army UC-64 Norseman. . . . Missouri Valley, Iowa, Airport, promoted by local businessmen, has completed two runways and a hangar and plans larger buildings next Spring. . . . Central Airways, Burlington, Iowa, Aeronca and Republic Seabee agent, now has 12 prefab hangars. . . . Horlick-Racine Airport, Racine, Wis., operated by Carlyle Godske of Racine Flying Service, now has three waterbound-macadam runways over 3,400 ft. long and a sod strip 3,500 ft. long, all clear of obstructions and permitting a 40:1 glide.

Sixth Region—Steve Noir has opened a 3,000 ft. airstrip at Puente, Cal., under name of Sky Ranch. Novelty is open air, umbrella-shadded restaurant for pilots and sightseers. . . . Torrance, Cal., Airport is first of chain organized by famed Maj. Joe Foss, ex-USMC, of Community Fliers, Inc. . . . Elsinore, Riverside County, Cal., is building a landing strip 2,500 ft. long with 12 individual hangars, under management of Gordon Hunt.

Seventh Region—Art Whitaker of Portland is now Piper distributor for district. Northern Aircraft Co., Seattle, is Taylorcraft distributor for Seattle and N. W. Washington. . . . Pacific Airmotive, Kent, Wash., announces that it is distributor for Ranger engines, Goodyear and U. S. tires, Sensenich props, Eclipse generators, B-G sparkplugs. It also has a well equipped instrument and repair shop.

Canada—Grey Rocks Air Service, St. Jovite, Quebec, is flying a camp supply charter service with Noorduyn planes. . . . Brisbane Aviation Co. of Vancouver, B. C., now fully reconverted, has reopened as a flight school. . . . Taylorcraft are being distributed in B. C. by Northwest Aircraft Distributing Corp. of Vancouver.



Ong Airport, Kansas City, Mo., formerly Richards Field when it was one of the Army airmail stops, is now a busy flight training and aircraft sales and service center.

AVIATION SALES & SERVICE

By **ARTHUR S. BROWN,** *Sales Manager, Scott Aviation Corp.*

The big rush is on for distributor franchises but, says this sales manager, "there'll be some changes made" by competition to give much more attractiveness and profits to those who sell the ultimate consumer.

ASK ANY MANUFACTURER of airplanes, parts, or accessories to name today's outstanding distribution need and the chances are a hundred to one the answer will be—"Well operated retail outlets."

It was perfectly natural in the prewar days for everyone to want to be a distributor, for unless an operator possessed a so-called distributor's franchise, he had small chance of working at a profit. In that prewar period there were few, if any, true wholesalers—most distributors were actually retailers even though they were not so designated.

And on the basis of overwhelming evidence this condition persists today to an alarming extent.

Manufacturers all over the country—both airplane and accessory producers—are constantly deluged with requests for distributorships. Regardless of the size of the applicant's business, the requests are for straight distributorships. This is due partly to the applicants' supposition that prewar conditions will continue to prevail, and that a distributor's franchise will simply mean a larger discount. In other cases it is based on the supposition that the business will continue as it has—where the vast majority of planes are owned by operators—so that the market therefore consists principally of sales to other operators.

Naturally, so long as this condition continues, a distributor franchise is the only one which can be profitable. But the time must come, and in the very near future, when the parts and accessory manufacturer will of necessity demand an adequate retail organization. At that time the distributor will be faced with one of two courses: Either to be satisfied with a narrower operating margin and cooperate with whatever retail outlets he may be able to produce, or simply to go out of business.

The aircraft distributor is in much the same position, as is shown by examples in nearly every community. In a great many cases the airport operator will have a distributor's franchise for at least one make of airplane, and in addition he may have a similar franchise for a few accessory items. He is usually inordinately proud of these distribution arrangements.

In many cases such an operator will have been furnished a list of inquiries by the manufacturer, and he is busy trying to sell planes to this list—on a retail basis. And in many of these cases, he may, in the process, have appointed one or more dealers; but his principal effort has been on sales, with little or no cooperation with the dealers he may have named.

Not only are such conditions evident today, but they may continue for a few months, largely because enough orders can be taken in the current ready market to justify a distributorship, and because the manufacturer, preoccupied with production problems, has not pressed too forcibly for establishment of a sound retail sales organization.

But when the first rush of orders has been filled and competition gets keen, as it inevitably will, such distributors will find themselves pushed more and more by their manufacturers to produce an honest-to-goodness retail sales setup. And at that time they may well find themselves in a most embarrassing position, because they will have been busy destroying the goodwill of the very people needed as retail outlets. In fact, it has been said more than once that some distributors are slated for business failure through their insistence on taking a long profit during the initial months of peacetime operation.

With the war over and competition bound to get tougher, aircraft and accessory distributors must of necessity begin to operate on a truly wholesale basis and, moreover, give a full measure of protection to the retailers who are the ultimate sales outlets for their merchandise.

This means that the distributors will no longer be able to "go through the back door" after the same business their retail outlets are seeking. It will mean that the distributors will have to give wholehearted support to their retailers even though this may appear to be a financial sacrifice.

It is unfortunate that this fundamental lesson—long since learned and accepted in other fields of merchandising—should still need selling in the aircraft industry. That it is necessary is evidenced by the case of one distributor who actually advertises the fact that he does not endeavor to take business away from his retailers.

It must be accepted in aviation distribution, as it has in other fields, that the distributor franchise is no longer a retail franchise carrying a greater discount. It must be exactly what the term implies. It has, as a matter of fact, been maintained that it is completely logical that the distributor have a smaller effective margin than the retailer. In many lines this is already true, particularly when the higher operating cost of the

(*Turn to page* 176)

Here's a plan to get some of that money that can't be spent on nylons and gadgets—and keep the profits rolling in by—

SELLING BLOCK TIME THROUGH GIFT CERTIFICATES

By ROBERT L. FLI

AIRCRAFT DISTRIBUTORS and flight school operators have an opportunity during the reconversion period which may never come again—for they now have a public with plenty of money to spend but not much in the way of consumer goods on which to spend it. Mr. and Mrs. J. Q. Public at present are actually searching for things to buy, but there just aren't enough waffle irons, nylons, refrigerators, tires, electric trains, and other items of the good life to meet the demand.

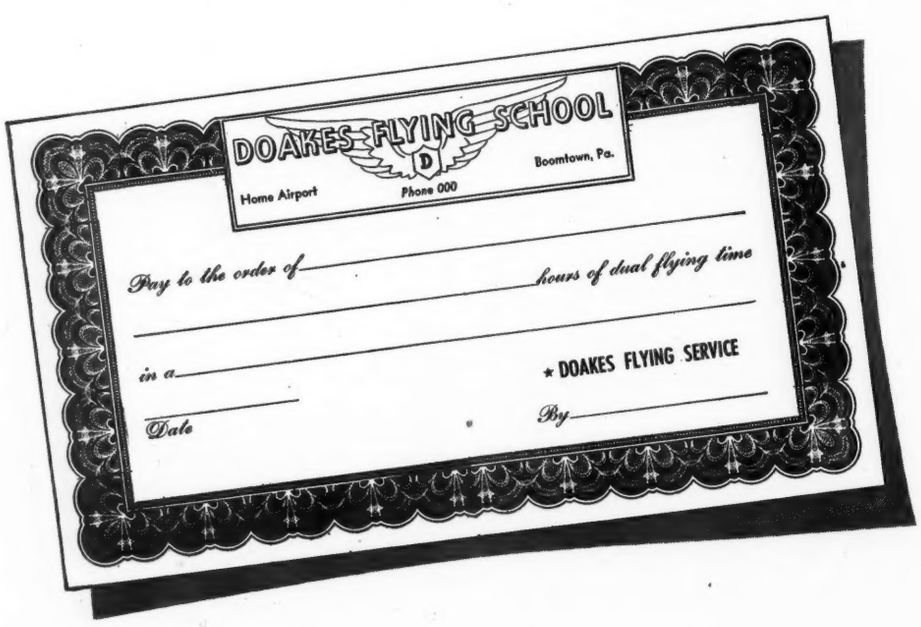
What does all this mean to the operator? Simply that he's got a service—not a scarce product—but a service to sell. He doesn't face any production problem. It is assumed that he has enough planes with which to keep in business so he can't argue that he faces that production difficulty. This service he has to sell is actually a commodity. Next year it probably won't be that way. Next year America will be back on peacetime schedules. Shirts, bathrobes, toys, household appliances—maybe even nylons will be widely available.

Admittedly there is buying power around, and there's an unusual opportunity for the alert operator to channel some of it into his bank account. That opportunity lies in selling block time—time which can be sold somewhat below regular rates and return a reasonable profit—though perhaps not a wartime profit. For instance, if he is selling time at $10 dual and $8 solo he might be able to get those figures down to $9 and $7 on block time even in fairly small amounts—say 2 or 3 hr. That would make it possible for him to sell 2½ hr. dual for $22.50 and the same time solo for $17.50. Either amount is about what a doting aunt of average means would spend on her niece or nephew for say, a birthday gift. Where the ante is higher—up in the $50, $75, or $100 class which a parent or wife or husband might spend—the operator can reduce his per-hour costs even more and still make a tidy profit. These figures are something each operator must figure out for himself, and that little chore is the first step in cashing in on the block time business.

A further idea in connection with rates is to charge less during the mid-week slack period than on Saturdays and Sundays, or to offer "matinee flights" as reported in AVIATION for October (page 166). This will have the effect of spreading out the work, of bringing fewer regular customers on week ends, or having them come during the week, even though they may have to make a special effort to get out from Monday through Friday. Also it will influence those non-flyers who have plenty of mid-week time, such as students, nurses, taxi drivers, transit men, ushers, newspaper men, and so on.

Next the operator should work up a little "gift certificate" or card of some kind which the giver can present to the recipient on the day of celebrating the birthday or other gift occasion. It just doesn't seem like a birthday party unless something tangible is there to be exchanged when the gift giving is going on. This card might well be about the size of a dollar bill and should fit into a similar sized envelope. Such cards may be bought from greeting card shops or manufacturers. Also it might be possible to pick up a supply of a standard form, have it printed with the name, address, and phone number of the flying school, a space to show the name of the person receiving the gift, the person giving it, the number of hours, both solo and dual, for which it is valid, and the planes on which it may be used if there are craft for which varying rates are charged. Also if different rates are used on week ends, the card should make it plain how much time under each rate is available. One thing which should not appear, however, is the amount of money the donor has spent—that would be like leaving the price tag on a gift. If preferred, the entire card could be

(*Turn to page* 180)



NOBODY LOVES A HOT PILOT

It's quite a step down from, say, an 8,800-hp. bomber to an 80-hp. civil plane.

By **CHARLES A. PARKER,** *Major, AAFATC, Retired*

Amplifying that proverb—"There are plenty of old pilots and plenty of hot pilots, but there are no old, hot pilots"—the writer, himself an ex-Army man, urges former war flyers to remember, constantly, that civilian planes are not high-powered combat craft.

WHILE A SMALL PERCENTAGE of ex-Army pilots will find commercial applications for their services, many others will be faced with the necessity of paying for their flying. Some will buy personal aircraft, but others will confine their flight to hired planes. This flying will be found to be quite different from what so many, whose sole experience has been military aviation, think it to be.

Channels for procuring a civil license are well defined, hence it is not difficult to acquire a certificate. The CAA Regulations (and incidentally, it is these Regulations as a whole that will now become the flyer's bible) read as follows in Parts 20.560 and 20.561 under "Military Competence":

"20.560—Pilot Certificate. Applicant who is, or was within the preceding twelve calendar months, a member of the armed forces of the United States and has served on solo flying status for a period of six consecutive months, will be deemed to have met the aeronatical knowledge, experience, and skill requirements of the Civil Air Regulations for the issuance of a pilot certificate with ratings appropriate to the military pilot rating held: *Provided,* That he passes a written examination on Parts 43 and 60 (General Operation Rules and Air Traffic Rules, respectively) of the Civil Air Regulations and submits reliable documentary evidence showing:

(a) that he is a member of the armed forces, or that he has been honorably discharged or returned to inactive status.

(b) that he is, or was, a rated military pilot, and

(c) his total solo flying time.

"20.561—Ratings. Ratings will be issued in connection with such a pilot certificates, or in connection with an effective private or commercial pilot certificate held, if the applicant meets the following requirements:

(a) Aircraft Type and Class Ratings. These ratings will be issued to an applicant who presents reliable documentary evidence showing that within the preceding twelve calendar months he has had at least ten hours of flying time during which he was the sole manipulator of the controls of an aircraft of the type and class for which a rating is sought."

We have omitted subsection (b) of Part 20.561 because it specifically refers to instrument requirements.

While the average military pilot has his logbook full of high horsepower and multi-engined operation, it may appear somewhat preposterous to have to fly ten hours in a simple lightplane to obtain a lower class rating. However, it is good procedure. No doubt many a pilot will be disappointed to learn that even the low hp. military trainer, which in latter days he would hardly have considered a device to fly, now has assumed the position of a substantial machine. Its operation is now translated in terms of a civilian pocketbook, and so it has taken on quite a new aspect.

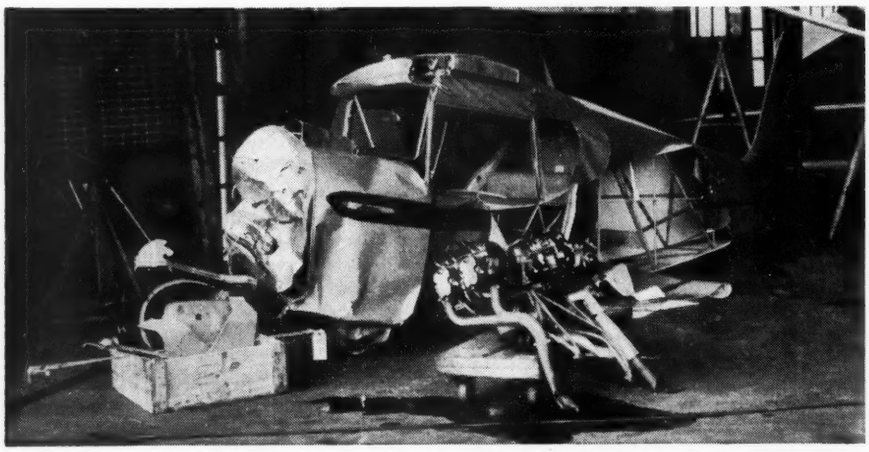
For such a machine, $15 an hour is not exactly chickenfeed. A plane of the Fairchild PT-19 class, purchased at a fraction of its original price, will stand the owner at least $10 per hour to operate. The returning pilot will find that aircraft of any really sizable power are as scarce among airport operators as they are difficult to justify economically. They cost from $20 to $40 an hour to hire and operate, and as a result it appears that the light and medium aircraft will become the lot of returning pilots who continue to fly.

This type of aircraft represents a decidedly pleasant manner of flying. For the pilot who is used to a cockpit choked with gadgets, meters, switches, and what-not, this piloting can be downright fun and it can be done with a surprising amount of relaxation and ease.

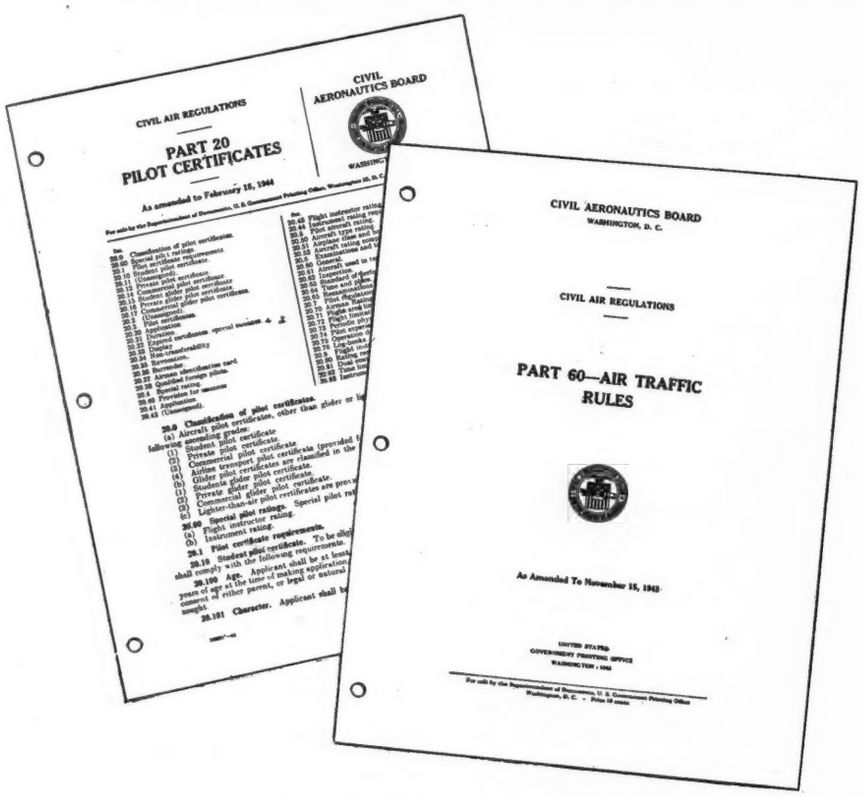
When flying for the first time with any operator, the renter pilot will undoubtedly be asked to "check out". No one should feel that this is a reflection upon his ability. It is merely a good common sense procedure despite the seeming simplicity of the aircraft in question. While the small craft found in civil aviation may be a cinch to fly, they are different, and for this reason alone it will never do any harm to review their peculiar characteristics with someone accustomed to them.

The fact remains that the unthinking flyer can get hurt in a 50 hp. airplane as seriously as in one of the lethal weapons entertained by the military. The pilot should retain respect for any and all planes, no matter how small. Don't swagger in flight and carry piloting to the ragged edge. There may be a time when the plane just won't do what some have unconsciously come to expect of an airplane, through being used to the reserves of power and safety of military craft.

Civil aircraft are safe enough, but they have limitations which should be respected just as were those of say, the B-24, There is no need to "beat" an airplane or its engine to have fun in flying. Again, the operator is particular in regard to the manner in which his equipment is handled—for it all comes back to the matter of dollars and cents *out* of his pocket.



This is what the author did in a cocksure moment of civil flight.



Civil Air Regulations comprise the civil flyer's "bible" and should be obeyed meticulously.

Speaking of check-outs recalls the incident of an Army pilot who had seldom flown civil type aircraft. This occasion was some years ago at a small airport where the pilot in question arrived in one of the old Martin Bombers. While at he field he thought it would be a nice idea to try out a 90-hp. two-place Fleet Trainer. He was rather taken aback at the idea that he—of all people—should require a check flight. After all, didn't he represent the chosen few, the highest phase of piloting experience? The airport manager was torn between the necessity of taking in every cent of revenue by not losing any customers (that were all too scarce) and still not losing either a customer or an airplane the hard way.

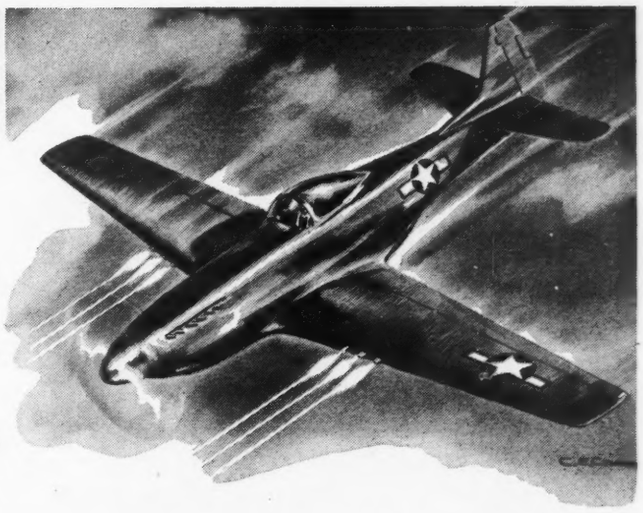
Against his better judgment the operator turned the airplane over to the pilot with only a few carefully chosen words of advice. The wobbly takeoff was overlooked, the thought being that the Army man would get the feel soon enough. And later, after doing a series of mild maneuvers aloft, our hero came in for the landing. With a disconcerting amount of speed, he lost altitude, and after skating along in the air over a good part of the field, he leveled off at a height just about equal to that of his bomber's cockpit.

Thereupon, the Fleet settled suddenly, then with an enormous wallop, it hit the field, to rebound and gallop between bursts of the engine for the remainder of the airport, winding up in low bushes off the end of the field, fortunately with little damage.

The Army man apologized, admitting the craft was a somewhat different airplane than what he was accustomed to. After that the manager never let a newcomer take an airplane without first receiving some cogent pointers and a simple check flight.

The factors involved are no different today from what they were in that particular case some 13 yr. ago.

The matter of damage is also different. With a civil plane, such things can't be written off as war or military expendability. Somebody much closer and more clearly identified than the taxpayer must dig down deep and pay for it in his own hard cash. Is it any wonder that the operator renting airplanes is particular? Not only does he want to protect his investment, but he has a reputation to uphold and any accident tends to mar the business outlook at his field. Also the pilot must answer to a rightfully critical CAA, nor should he forget that *he can be held personally* for any damage. A forced landing in a bean field recently cost one pilot $500.



If the returning military pilot forgets that his low-powered civil craft is not a 2,000-hp. fighter, the fact will soon show up under unpleasant circumstances.

The least any flyer can do is respect local field rules and the basic concepts of good flying. It is well to recall that pilots of all degrees of ability and experience are mingling in flight, from the 5-hr. solo student to the 5,000-hr. "whiz." Actually the whole business of civil aviation, its regulations, its current profits, and its futures, all hinge on the matter of its safety record. Everyone who flies, therefore, influences its status, both for today and for tomorrow.

While the lightplane is relatively simple to operate, it calls for a different psychological approach. With a little common sense and a full knowledge of its limitations, it can be used to go places and do things in a surprising fashion.

The writer, in the prewar days, operated light aircraft over a large area, ferrying them from Ohio and Michigan to New England under a wide range of winter and summer weather. This was done mostly without the use of radio, primarily calling for basic contact flying. It is surprising what can be done with an ordinary compass, a chart, and a watch.

It is much better, the author found, to start out of Ohio in the winter season in a 65-hp. Aeronca and fly it to Boston than to repeat the automobile trip he performed over that same route several years ago. The icy roads and foothills of New York State, plus the crossing of the Berkshires, made driving brutal; a similar ordeal was never encountered in any airplane flight.

As for weather, there will always be holdups. Yet, in the year 1940 we flew some 14,000 mi. cross-country, mostly in lightplanes, with only two nights lost due to weather. This may be the exception, but it is an illustration of what can be done once the lightplane is accepted and proper thinking applied to its operation.

That many military pilots look askance at the small civil airplane is to be expected. We recall how an Army pilot, who had just taxied a civil-type amphibian in a rather high wind, remarked how hard these "small" airplanes were to handle under such conditions. Obviously, the small airplane isn't a Douglas DC-3. It is far more vulnerable in a high gusty wind. In addition, it is of light construction, but it will perform and can do a job, and it is built to take a surprising amount of hard use *of the kind for which it is intended.*

A word now regarding the airport operators: Whether the returning pilot owns his own plane or hires one, he will be dealing considerably with the operators who, being independently engaged in business, are responsible in full for their operations and conduct them accordingly. They will probably resent being bluntly told how to run their enterprises or any inference that their procedures are over-cautious. Unlike Uncle Sam, the operator has no taxpayers to foot his bills; his entire income depends upon how he runs his business.

Even so, most operators are very lenient, considering what they have at stake. If they appear to view matters with one eye squinted, this can be accounted for by their past history. The newcomer to flying should remember that many old timers have come up to their present status only through long years of hard work and risk. They came up in a profession in which one was lucky at times to take in even enough money for "three squares" per day, so in their position they have a right to be calculating.

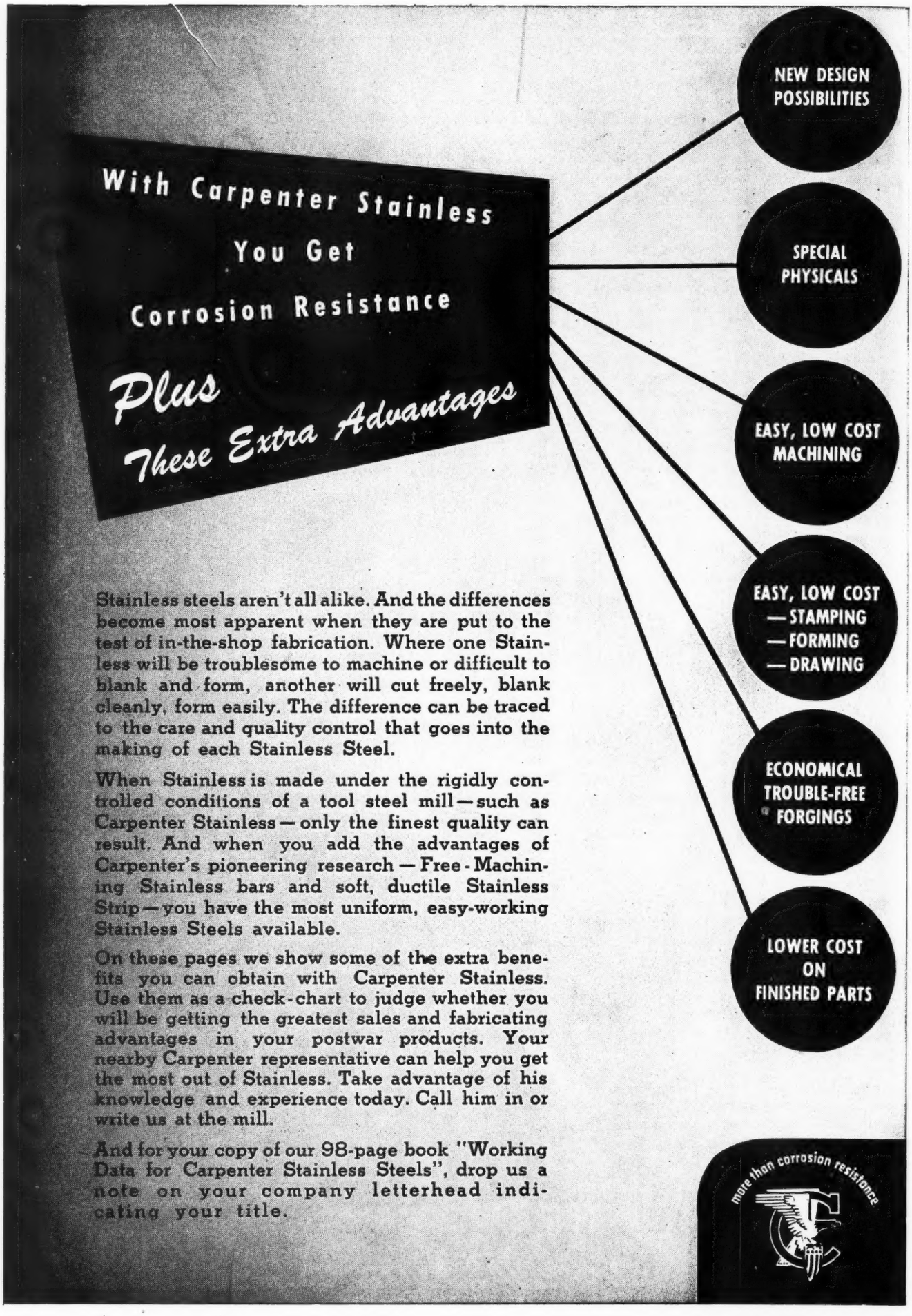
Unlike combat planes, civil aircraft must conform to a dollars-and-cents economic restriction, and this determines their performance and capacity.

Many of the old line operators were flying when the present crop weren't even knee high to a tail skid. They flew aircraft that frequently offered nothing but risky venture by the best of yardsticks, and perhaps they were at one time the only experienced pilots in their vicinity.

They are people who loved their profession or they wouldn't have stayed in it and weathered the storm. There was often little legitimate reason for many to fight on, other than this love and the hope that some day the business might show some real financial return. They justly deserve credit as pioneers; moreover, in the recent war days, they made an enormous contribution to the military effort, many pilots of World War II having started their flying careers through the facilities of these operators.

It is hoped that the returning military pilot will bear all these points in mind when he turns to civil aviation. If he appreciates the position of the operator and the true status of civil flying, meanwhile recognizing the limitations of the civil airplane, he will be getting off on the right foot.

General improvement of civil flying, lessening of restrictive regulations, better insurance rates, etc., all call for everybody to do the right thing and thus build a safe and sane record. As a past operator, commercial pilot, and ex-member of the AAF, the writer suggests that we shelve the military psychology of flight and start off by bearing in mind that every civil-flying newcomer, whether he be a former military pilot or not, can do his part to help build civil aviation on the right basis and make it a successful venture with a bright future.


With Carpenter Stainless
You Get
Corrosion Resistance
Plus
These Extra Advantages
NEW DESIGN POSSIBILITIES
SPECIAL PHYSICALS
EASY, LOW COST MACHINING
EASY, LOW COST — STAMPING — FORMING — DRAWING
ECONOMICAL TROUBLE-FREE FORGINGS
LOWER COST ON FINISHED PARTS
Stainless steels aren't all alike. And the differences become most apparent when they are put to the test of in-the-shop fabrication. Where one Stainless will be troublesome to machine or difficult to blank and form, another will cut freely, blank cleanly, form easily. The difference can be traced to the care and quality control that goes into the making of each Stainless Steel.
When Stainless is made under the rigidly controlled conditions of a tool steel mill—such as Carpenter Stainless—only the finest quality can result. And when you add the advantages of Carpenter's pioneering research—Free-Machining Stainless bars and soft, ductile Stainless Strip—you have the most uniform, easy-working Stainless Steels available.
On these pages we show some of the extra benefits you can obtain with Carpenter Stainless. Use them as a check-chart to judge whether you will be getting the greatest sales and fabricating advantages in your postwar products. Your nearby Carpenter representative can help you get the most out of Stainless. Take advantage of his knowledge and experience today. Call him in or write us at the mill.
And for your copy of our 98-page book "Working Data for Carpenter Stainless Steels", drop us a note on your company letterhead indicating your title.
more than corrosion resistance

LOW UNIT COST

When made from Carpenter Stainless No. 6 (Type 430), kitchen implements can be low priced yet more appealing.

EYE APPEAL

Eye-catching designs in sparkling Stainless! A light gauge of Carpenter Stainless No. 6 (Type 430). Strip was used here without sacrifice of strength and rigidity.

DESIGN FLEXIBILITY

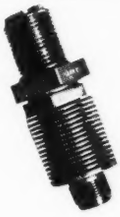
Lighter gauges and sharper radii are possible with this versatile metal as illustrated by these typical shapes of rolled molding.

HEAT RESISTANCE

Carpenter Stainless No. 4-TI (Type 321) or No. 4-CB (Type 347) used in the aircraft exhaust manifolds are examples of a wide range of Stainless grades that meet high temperature service requirements.

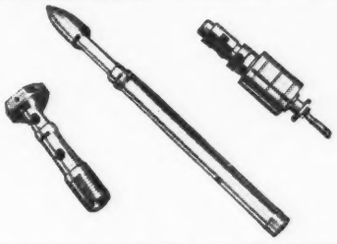
ELECTRICAL RESISTANCE

The uniform electrical resistance and easy-forming properties of Carpenter Stainless No. 1-JR (Type 406) are essential in this edge-wound resistor coil used in cargo ships.



AN EXCELLENT EXAMPLE

of the results obtainable with Free-Machining Stainless No. 5 (Type 416) can be seen in this finned aircraft spark plug.



EXTREMELY CLOSE TOLERANCES

Carpenter Free-Machining Stainless No. 8 (Type 303) met rigid machining requirements on these aircraft carburetor parts yet maintained the tremendous production volume necessary.

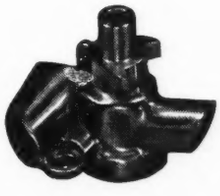
REJECTS CUT 50%

In one temperature control instrument Carpenter's soft and ductile Stainless Strip halved rejects on some 200 different parts.

Diameter—2 15/32"
Depth—3 3/16"

NO PROCESS ANNEALING

was needed to deep draw this steam trap bucket to a cup depth of 3½". Carpenter Stainless No. 4A (Type 304) used in 6¾" x .026" coils, kept rejects to a minimum, cut die wear and speeded output.

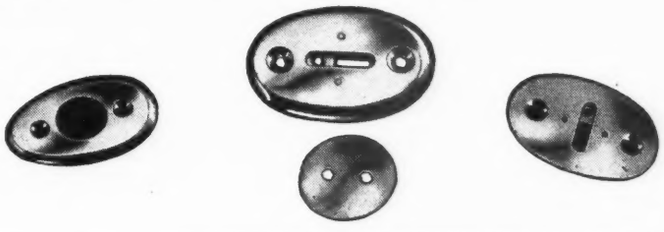


SOUND FORGINGS

This aircraft fuel supply valve body was easily forged from Carpenter Stainless No. 8 (Type 303). All Carpenter Stainless forging bars are rolled from machine-turned billets to assure flawless surfaces.

POSITIVE PROTECTION

against corrosion plus the required strength and hardness made Stainless a natural choice for these forged dental and surgical instruments. Clean, flawless Carpenter Stainless forging stock reduced rejects, increased output.



FINISHING COSTS CUT 28%

And that's typical of results obtained on these truss belt plates because a switch was made from a plated nonferrous metal to Carpenter Stainless No. 6 (Type 430). Strip with our famous ABC finish.

The Carpenter Steel Company • 205 W. Bern Street • Reading, Pa.

Carpenter STAINLESS STEELS

BRANCHES AT Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, Providence, St. Louis

*By Flying Boxcar

Air Shippers have their eyes on inland ports—the small cities with limited length runways.

Their interest turns naturally to the Fairchild "Packet."

For the "Packet"—expressing the painstaking research and precise engineering typical of *all* Fairchild operations and products—can:

GET IN, fully loaded with up to nine tons of flying freight, on average and less-than-average length runways.

UNLOAD AND LOAD, swiftly, with a minimum of manipulation. The "Packet's" split-tail doors at the rear open up the entire width of the boxcar-like fuselage. The forward cargo door permits quick access to "up front" freight. The "Packet's" horizontal cargo floor is at truck-floor height.

GET OUT, fully loaded, with a short run. It has take-off characteristics highly exceptional for a plane of its large cargo capacities.

All these characteristics are invaluable to the shippers seeking to tap the rich markets of the interior. They are characteristic of the "Packet" alone among cargo planes, because the "Packet," from its conception, was designed and built *specifically* to carry cargo—efficiently and economically—anywhere! They are the Fairchild "touch of tomorrow" in this plane of today!

Cargo operators—write for details about the "Packet."

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland

ENGINE RELIABILITY ENHANCED BY "STRESSCOAT" ANALYSIS

PART I

By CHESTER S. RICKER, *Detroit Editor, "Aviation"*

BY SUBJECTING aircraft engine parts to "Stresscoat" analysis—an ingenious diagnosis involving the use of a brittle lacquer coating to indicate quantitative strain values—engineers of Continental Aviation & Engineering Corp. have been able to redesign power plant components to make them stronger and, frequently, lighter.

And axiomatic assumptions concerning type, amount, and distribution of stresses in engine parts have been disclosed as erroneous by this lacquer method of testing—a method which greatly reduces the factors of time and expense, as compared with cut-and-try procedure, in new design.

Development of a brittle lacquer coating to indicate quantitative strain values was started at MIT*, and the present lacquer Stresscoat is the result.

Referring to customary engineering practice in the past, William T. Bean, chief of Continental's experimental stress laboratory, states: "A few ribs usually were added, here and there, to 'strengthen' castings. Fatigue failures often resulted and more ribs were thrown in. Today, we are eliminating ribs because Stresscoat has shown that they are stress-raisers. If high thin ribs undergo cyclic loads without failure, they aren't needed. If they do fail, extra fatigue strength can be added by removing the ribs and redistributing the metal."

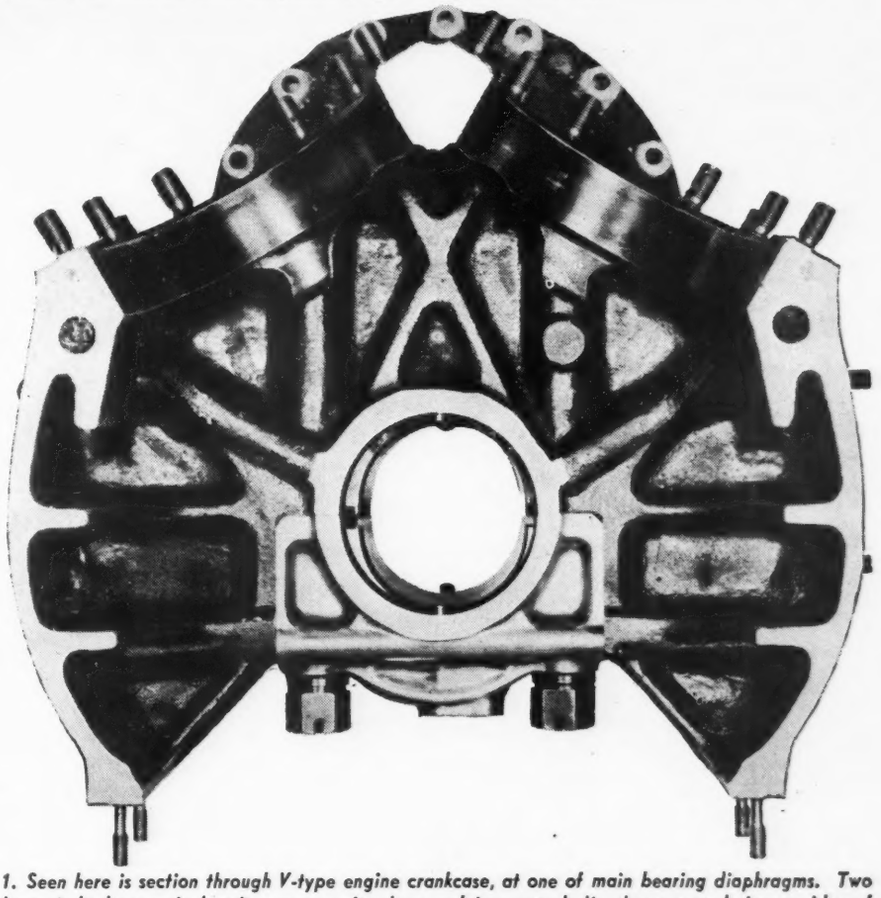
Although one redesigned cast part is now 4 percent lighter than formerly, it is now 40 percent stiffer and has never broken. Another unit was increased 50 percent in weight but failures continued. After diagnosis, the part was redesigned and weight reduced to original value, with no failures encountered. Changing position of oil holes, after analysis, was another step toward better design. And parts originally designed only for bending were found through diagnosis to be subject instead to critical torsional strains.

Practical application of Stresscoat in the diagnosis of aircraft engine structures is a technique which demands a clear perception and understanding of the service requirements of a part tested, skill in applying the coating, and ingenuity in making and diagnosing specimen photos. Going directly to the results of the technique, case histories of a number of aircraft engine parts subjected to cyclic loads will be considered, and original and final design compared.

Typical examples of Stresscoat utility are discussed in connection with:

(1) Crankcase
(2) Crankshaft
(3) Crankpin oil holes
(4) Main bearing cap
(5) Supercharger housing, and
(6) Camshaft housing

Each one of the examples shown in this two-part picture story, reveal what has been done for better design and improved service.



1. Seen here is section through V-type engine crankcase, at one of main bearing diaphragms. Two long studs draw main bearing caps up in place and two cross-bolts clamp caps between sides of case. Crankcase walls are well-ribbed with aim to afford strength and stiffness. This was initial design.

* *Strain-Indicating Lacquers,* Master's Thesis, by Greer Ellis, Aeronautical Engineering Department, Massachusetts Institute of Technology, 1937.

Solar Exhaust Manifold *"In Action"*

THE ABOVE PHOTOGRAPH, taken in complete darkness without artificial lighting, dramatically shows the intense heat Solar airplane exhaust manifolds experience in service. This punishment goes on hour after hour for thousands of hours—a striking testimony to Solar workmanship.

During the past 15 years, Solar has fabricated over 300,000 engine sets of airplane exhaust equipment representing more than 1000 designs. The "know-how" gained extends over all stainless steel forming techniques from deep drawing to precision casting.

If your problem is manufacturing heat or corrosion resistant products from stainless steel or other high temperature alloys, consult Solar. Wire or write for helpful information.

ARMY ★ E ★ NAVY
ARMY ★★ E ★★ NAVY

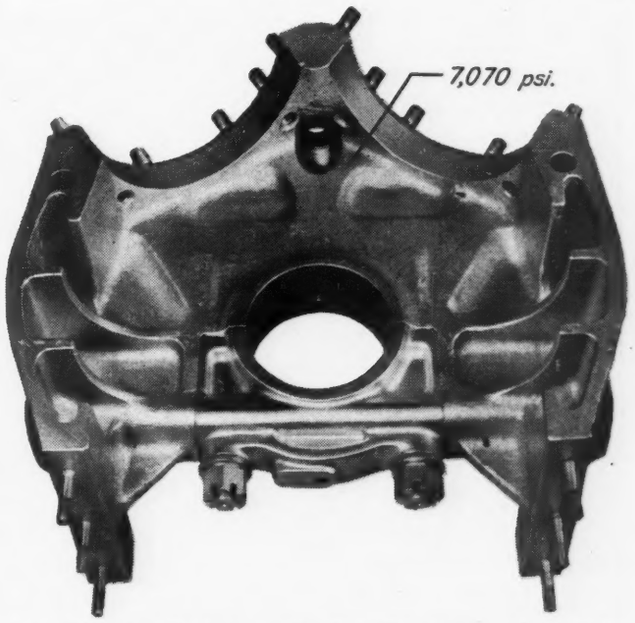
SOLAR

STAINLESS STEEL PRODUCTS

SOLAR

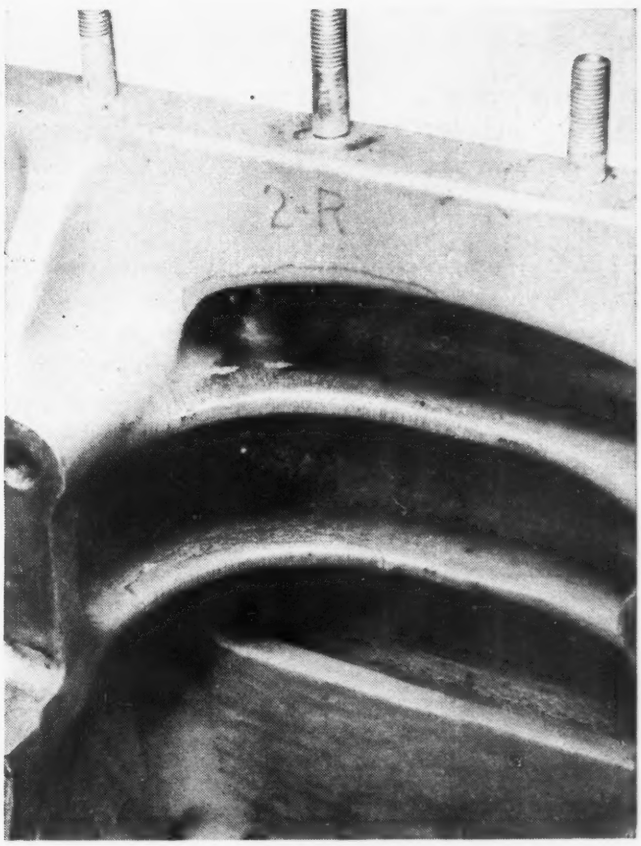
SOLAR AIRCRAFT COMPANY ★ SAN DIEGO 12, CALIF. ★ DES MOINES 5, IA.

2. As shown, there was failure under cyclic operating stresses, fracture starting at bottom of stud where diagnosis indicated stresses were maximum and concentrated. Shorter stud and new pattern of ribs was first improvement.



3. By thickening diaphragm wall, eliminating bosses, and shortening main bearing cap studs this design resulted. Stresscoat diagnosis showed that highest stress was in two top central ribs about the vertical hole.

4. In this close-up of critical area indicated in (3), Stresscoat lines show location of strains.



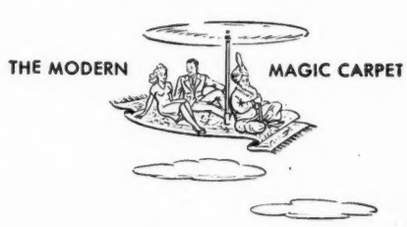
5. Stresscoat on crankcase sidewall ribs shows action of latter as stress-raisers and indicates desirability of their removal.

"The Modern Magic Carpet"*

LIKE the magic carpet of Arabian Nights, the Bell helicopters will offer a new concept of flying. For these helicopters can fly forward . . . backward . . . sideways . . . and ascend and descend vertically. They can land in or take off from otherwise inaccessible terrain. They can carry passengers and cargo from door to door. They can hover motionless in the air to perform specialized functions. Truly here is an aircraft that will become "The Modern Magic Carpet."

The Bell helicopters, at present, are not being developed to replace the family flivver. They are designed for many practical commercial, industrial and military applications—for public service of a kind which only the helicopter can perform. And Bell Aircraft engineering is conclusive evidence that they incorporate the advanced thinking in design and workmanship which has won this company its reputation of being the *"Pacemaker of Aviation Progress."*

**Reg. applied for U.S and principal foreign countries.*



BELL *Aircraft* CORPORATION

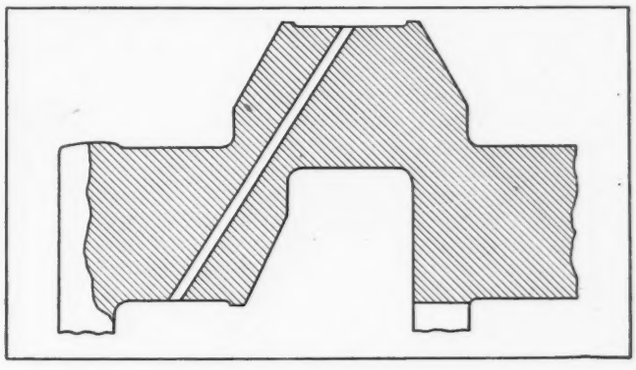
Buffalo 5, New York

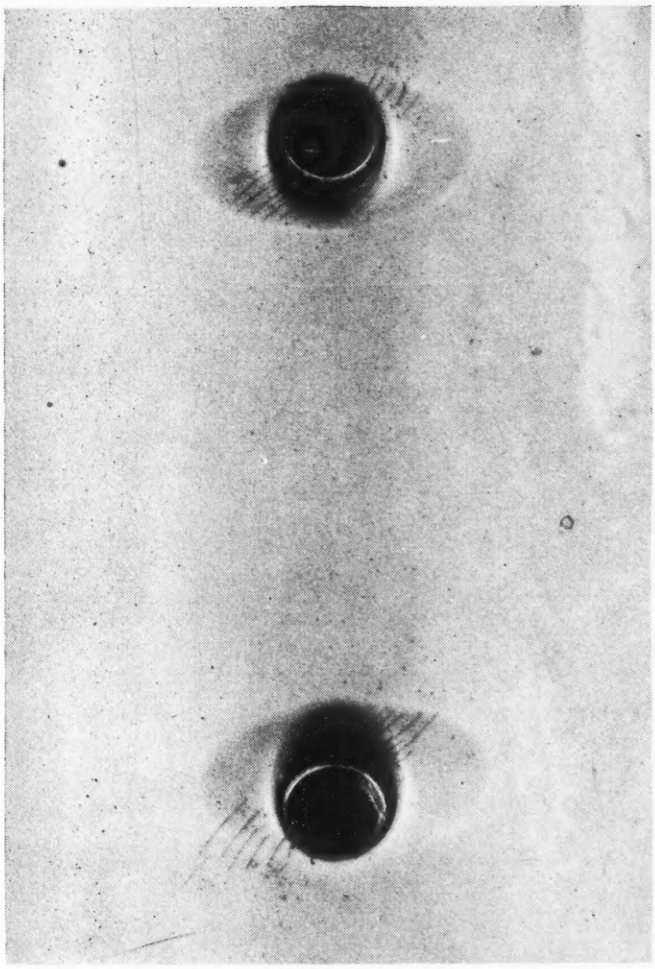
© Bell Aircraft Corporation

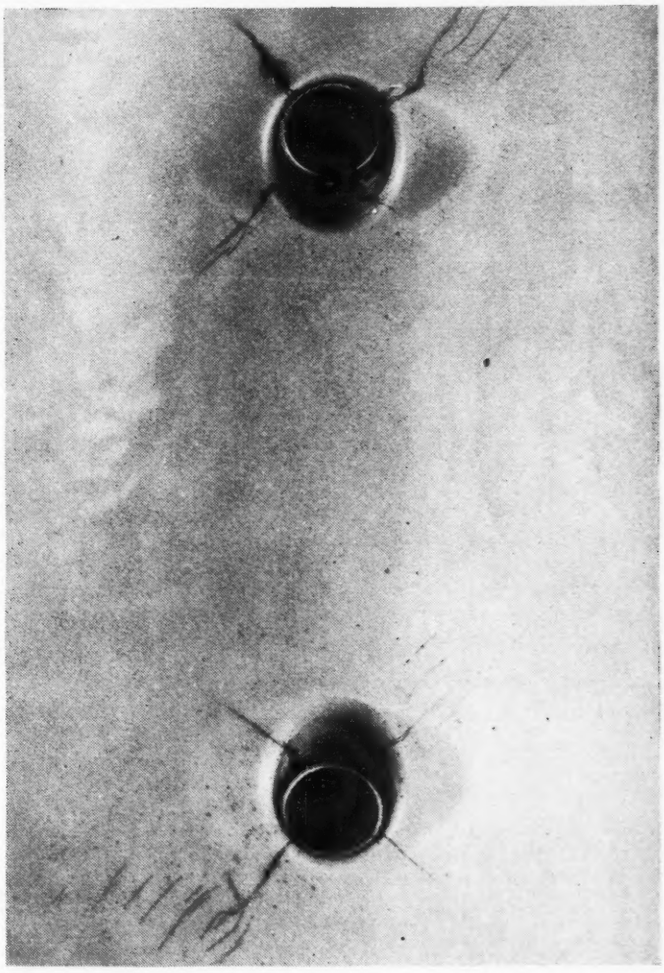
PACEMAKER OF AVIATION PROGRESS

6. Based on Stresscoat diagnosis, this final form of crankcase is result of gradual transition from one wall thickness to another and complete elimination of ribs from sides. Case is lighter, stiffer, easier to cast and keep clean, and has longer life.

7. Sectional view showing how oil holes were originally arranged in solid crankshaft because of convenience of manufacture. This placement caused holes to act as stress-raisers and resulted in cracking because of torsional strains.







8. (left): With oil holes on top of crankpin, Stresscoat lines indicate stress concentration. Right: Repeated torsional strains caused crankpin to fail around oil holes at 45 deg. to axis of pin—as would be expected from analysis shown at left. These are actual service cracks —failures which had been clearly predicted by the appearance of the Stresscoat lines.

REVIEW OF PATENTS

By A. HARRY CROWELL,
Registered Patent Lawyer

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10¢ each, directly from U. S. Patent Office, Washington.

Airplane Control System, designed to increase maneuverability of craft and reduce pilot effort, eliminates rudder by incorporating elevator-equipped rotatable tail portion converging to tail tip, elevators serving to produce rudder action.—2,386,915, filed May 25, '42, pat. Oct. 16, '45, G. Spittler.

Method of Mooring Dirigible to mast consists of flying craft substantially horizontal toward mast, lowering bow into closely spaced relation to ground at mast's leeward side, attaching bow to mobile ground car to prevent vertical movement of craft, moving ground car toward mast to engage craft's nose with mast while manipulating yaw lines to prevent undesired lateral or over-riding movement, and finally disconnecting ground car from craft.—2,386,814, filed Aug. 6, '43, pat. Oct. 16, '45, C. E. Rosendahl and O. Loeser, Jr.

Control Apparatus in automatic system for positioning control surfaces is designed to embody means for varying ratio between surface movement and movement of controlling device as non-linear function of craft's airspeed and altitude.—2,387,795, filed Mar. 26, '43, pat. Oct. 30, '45, S. G. Isserstedt, assignor to Minneapolis-Honeywell Regulator Co.

To Overcome Rudder Locking, new control means automatically functions when plane is angled, so as to insure flow of air over stabilizer face opposite to face receiving major flow. Forward portion of vertical stabilizer has series of alternately arranged nozzle-shaped slots extending transversely from one side to other. As airplane is angled about C.G., certain of the slots are so presented that air is taken in and delivered to opposite side of stabilizer and directed to rudder face on that side, thus increasing pressure on side of rudder and reducing differential pressure between rudder faces.—2,387,526, filed May 19, '43, pat. Oct. 23, '45, H. T. Nagamatsu, assignor to Curtiss-Wright Corp.

Cargo Airplane is provided with separable bottom load-carrying body capable of being transferred to, flown with, and separated from craft and delivered (by truck and trailer units) to destination remote from airport. Body has stress construction similar to craft, and when fitted to latter it becomes integral part of same. When body is separated from craft, latter is sufficiently strong for taxiing.—2,387,527, filed May 19, '43, pat. Oct. 23, '45, H. T. Nagamatsu, assignor to Curtiss-Wright Corp.

Anti-Icing Device for installation in hollow aircraft part, such as airfoil, comprises rotatably mounted pipe, air-impelling means mounted in heat-conductive relation on exterior of pipe, and means for internally heating and rotating pipe. Object is to provide moderate and uniform heat and avoid local or general overheating of aircraft parts.—2,387,637, filed Dec. 17, '42, pat. Oct. 23, '45, L. E. Bierly.

Aircraft Heating Apparatus is designed to provide improvements for supplying air to heater combustion space and, also, for circulating heated air through distribution pipes, at volume rates which vary inversely with density of air and effect more uniform heating despite substantial variations in altitude, temperature of surrounding air, and atmospheric density. Employed is fan driven by series-wound motor energized by current from constant voltage source.—2,387,538, filed Sept. 4, '41, pat. Oct. 23, '45, F. O. Hess, assignor to Selas Corp. of America.

Transparent Pilot-Enclosure having hoop tension characteristics is designed to provide strong, light, inexpensively fabricated structure affording improved visibility, aerodynamic efficiency, and ability to withstand relatively high pressure differential. Unit is positioned over pilot's seat so that, when seated, pilot has head extending beyond the confines of fuselage and into bulbous enclosure. Removable portion of enclosure is sufficiently large for passage of human body in emergency.—2,385,684, filed Sept. 21, '42, pat. Sept. 25, '45, E. F. Burton and A. B. Rogers, Sr., assignors to Douglas Aircraft Co.

High-Stability Aircraft is of design particularly intended to possess substantially as good longitudinal stability characteristics at speeds approaching that of sound as it has at lower speeds. Horizontal airfoil is spaced longitudinally from wing and so formed as to produce decreasing aerodynamic reaction, at given angle of attack, proportionately at least as great as decreasing lift of wing upon increase in speed in range above that corresponding to critical Mach number.—2,385,845, filed Mar. 15, '43, pat. Oct. 2, '45, G. S. Schairer, assignor to the Boeing Aircraft Co.

Aircraft Static Charge detecting and neutralizing apparatus, employing simple and highly sensitive bridge circuit, is designed to automatically maintain substantially neutral potential with respect to field through which craft is flying. Negative ions are collected from exhaust vapors in sufficient amount to neutralize positive charge carried by plane.—2,386,6 7, filed Feb. 24, '41, pat. Oct. 9, '45, G. J. C. Andresen.

Airfoil Structure of light gage metal includes means for effectively decreasing tension stresses tending to rupture connections of trailing section with opposite sides of nose section. For convenience of construction and assembly with use of spotwelding, and to facilitate inspection procedure, leading and trailing edge sections are formed as separate subassembly units which can be readily joined together in final assembly operation.—2,386,170, filed May 17, '43, pat. Oct. 2, '45, M. Watter, assignor to Edward G. Budd Mfg. Co. . . . In another patent involving same parties, invention is concerned with airfoil construction embodying leading and trailing sections connected by spar and associated parts. Aim here is to arrange and connect various parts of structure so that shear loads are minimized at connections of relatively thin gage metal, as between nose covering and spar member.—2,386,522, filed May 25, '43, pat. Oct. 9, '45.

Avigation Device for dead reckoning, intended to obviate usual burdens of computation, provides calculator for deriving heading and ground speed for given course under given wind conditions, for indicating instant position on given course, and for revising assumed wind data and values which are derived from latter whenever avigator obtains flight fix and evaluates departure from desired course.—2,386,555, filed July 29, '41, pat. Oct. 9, '45, H. R. Hughes and S. A. Bell, assignors to Hughes Tool Co.

Landing Gear Wheel Rotation Device, intended for use preparatory to landing, features air turbine and mechanism for supplying turbine with motive fluid.—2,386,301, filed Aug. 14, '43, pat. Oct. 9, '45, E. H. Duke and J. L. Wait, Jr.

Novel Aircraft designed to take off or descend substantially vertically—to eliminate need for runway and thus reduce area of lifting surface required—has relatively large propellers mounted between nose and tail sections, with wings projecting from forward end of tail section immediately behind propellers. For takeoff and landing support in vertical position, craft is equipped with plurality of leg members extending rearwardly along fuselage and capable of being spread to provide structure with wide impact-cushioning base.—2,387,762, filed Jan. 25, '41, pat. Oct. 30, '45, L. H. Leonard.

Method of Fabricating aircraft structures is particularly applicable for joining separately formed pieces of plywood united by plastic. Meeting-faces of parts are treated with plastic material capable of being softened or melted by heat for raising to critical temperature, and parts are then subjected to pressure to cause uniting by plastic.—2,388,485, filed Sept. 20, '41, pat. Nov. 6, '45, M. Jensen, assignor to Langley Aviation Corp.

Airplane Towing Mechanism provides connecting means between bombing plane and fighter plane by which latter may be towed and refueled during flight, with connections capable of being broken so that each craft may fly as separate units.—2,388,013, filed Mar. 25, '42, pat. Oct. 30, '45, O. Rasor.

Improved Air Scoop is designed to provide means for automatic actuation of hot air control valve in hot air connection, to effect opening for admission of hot air to carburetor incident to every closing of carburetor throttle valve; also to cause movement toward closed position to cut off hot air in accordance with extent of vacuum or suction created with opening of throttle valve and flow of cold air to carburetor.—2,388,028, filed Mar. 14, '42, pat. Oct. 30, '45, T. C. Barber.

Recent Books

AERONAUTICAL TRAINING, by Charles A. Zweng and Allan C. Zweng. Pan American Navigation Service, N. Hollywood, Cal. 252 pages, drawings. $3.00.

Revised volume of a quiz system for commercial pilots covering the field of general aeronautics and written to prepare the private and commercial pilot for the government examination. The section covering C.A.R. has been rewritten to cover 1945 amendments. Included is a section dealing with the required flight maneuvers and points in each maneuver on which the applicant is checked and graded.

AERIAL NAVIGATION, by H. E. Benham. John Wiley & Sons, Inc., N. Y. C. 344 pages, drawings. $4.00.

Presentation of underlying theory relating to avigation, with practical instruction in modern techniques. Slanted toward the student, book is described as avoiding "the substitution of rules of thumb and jingles for explanation."

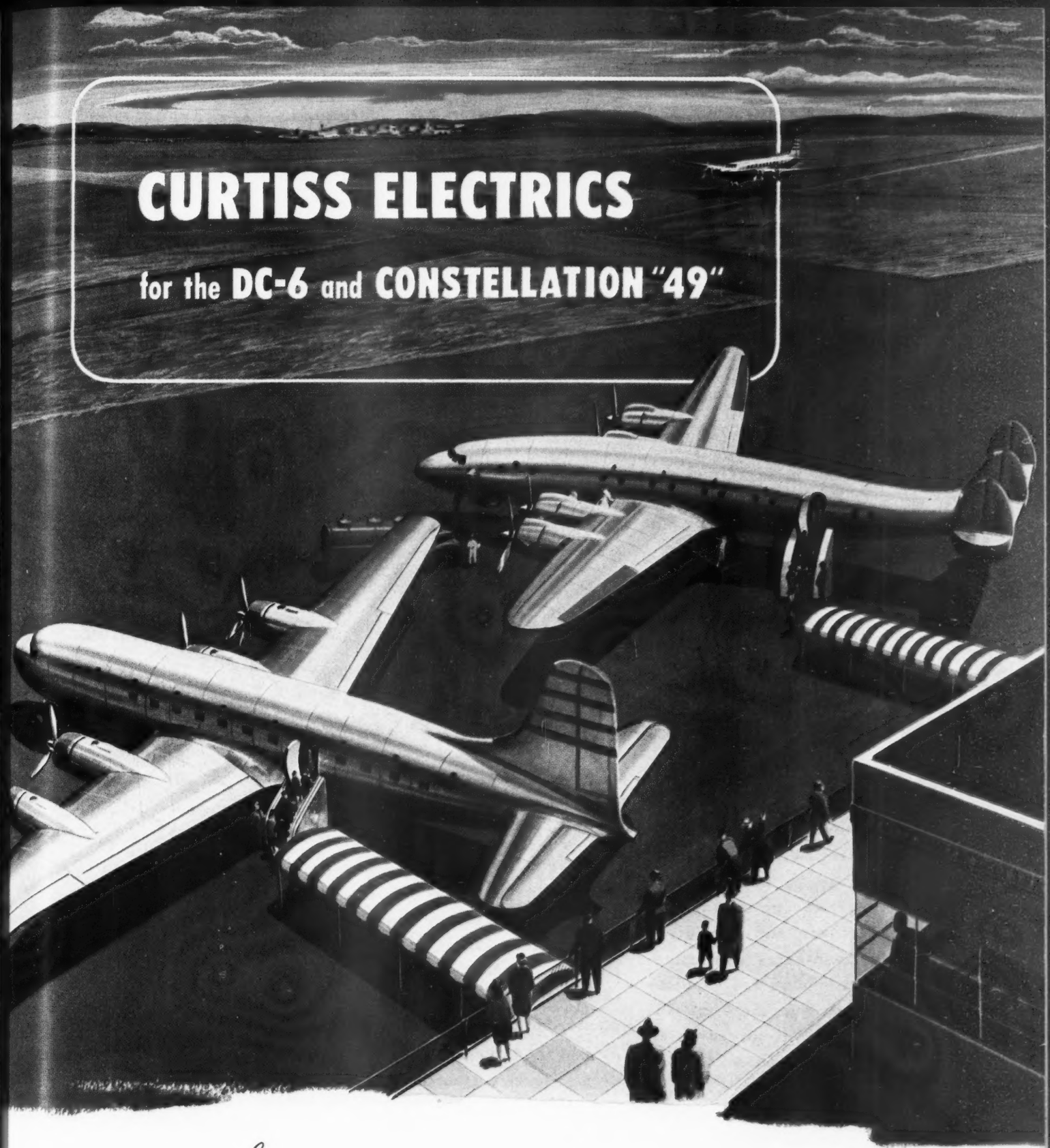
EARLY POWERPLANE FATHERS, by A. F. Zahn, Ph.D. University Press, Notre Dame, Ind. 39 pages, photographs, drawings.

Well illustrated and interesting historical review of attempts to develop powered aircraft prior to 1900. Work of Henson, Goupil, and Ader is detailed.

ENCYCLOPEDIA BRITANNICA WORLD ATLAS. C. S. Hammond & Co., 80 Lexington Ave., N. Y. C. $12.50.

To the aviation industrialist, as well as to the pilot, traveler, and student of the air age, a comprehensive volume of world maps and geographical data is indispensable for

(*Turn to page* 196)



the Scene is any large airline terminal. The aircraft are the new Douglas DC-6 and the Lockheed Constellation "49"—bringing to the commercial airlines new standards in passenger comfort—featuring the Curtiss Automatic Synchronizer for quieter, simplified engine control and Curtiss Aerodynamic Braking by reverse thrust for shorter, smoother landings.

CURTISS ELECTRIC PROPELLERS

A Division of Curtiss-Wright Corporation

Wall-type ANEMOSTATS in this plane are located on the side-walls near the floor.

AIRCRAFT HEATING AND VENTILATING *needs* DRAFTLESS AIR-DIFFUSION!

Heated or ventilating air blown into the cabin of a plane through old-fashioned grilles, registers, or slots creates drafts, permits stale air-pockets and stratification of temperature and humidity. Such annoyances can make the best heating and ventilating system a nuisance instead of a comfort to air-travelers. These are problems of *air-diffusion.*

ANEMOSTAT draftless air-diffusers solve air-diffusion problems. Thousands of ANEMOSTAT installations are conclusive evidence that aircraft heating and ventilating needs *air-diffusion.*

Due to its design (patented) the ANEMOSTAT distributes air of any duct velocity in a multiplicity of planes traveling in all directions. Simultaneously, it creates a series of counter-currents which siphon cabin air equal to about 35% of the supply air *into the device,* where it is mixed with the supply air before it is discharged. The ANEMOSTAT effects air expansion within the device, which instantly reduces velocity.

ANEMOSTAT air-diffusers have been engineered to the special—and often extreme—requirements of thousands of Army, Navy, and commercial airline planes. To be certain of heating and ventilating that is a comfort instead of a nuisance, all future commercial aircraft will need *draftless* air-diffusers engineered to their individual requirements. A consultation with one of our engineers regarding your special conditions involves no obligation.

AC-1045

WRITE TODAY FOR FURTHER DETAILS

ANEMOSTAT

REG. U. S. PAT. OFF.

ANEMOSTAT CORPORATION OF AMERICA
10 East 39th Street, New York 16, N. Y.

"NO HEATING OR VENTILATING SYSTEM IS BETTER THAN ITS AIR-DISTRIBUTION"

SHEET NUMBER D-35
CLASSIFICATION . . . . . Induction Heating
SUB CLASSIFICATION . . . . . Physical Constants of Metals

Induction and Dielectric Heating Data

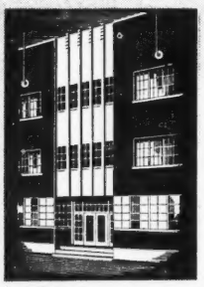
Physical Constants of Metals (20 Deg. C. Unless Otherwise Specified)

Material	Resistivity Microhms/CC.	Temp. Coeff. of Resistance	Specific Gravity	Specific Heat	Coeff. Thermal—Cond.
Aluminum	2.688	.00403	2.70	.214	.5
Barium	9.8	.0033	3.78	.068	
Beryllium	10.1			.397	
Brass	8	.002	8.6	.092	.204
Bronze	17.8	.0005	8.8	.086	
Carbon	3500 at 0°	.0009	3.52	.165	
Calcium	4.59	.00364 (0–600)	1.54	.157	
Chromium	2.6 at 0°		6.92	.11	
Cobalt	9.7	.00658 (0–100)	8.71	.10	
Copper	1.724	.00393	8.89	.0921	.918
Gold	2.44	.0034	19.3	.0312	.7
Graphite	800 at 0		2.25	.17	
Iron	9.8	.0065 (0–100)	7.8	.107	.161
Iron Cast	79–104		7.03	.118	
Lead	22.0	.0039	11.4	.0306	.083
Magnesium	4.46	.004	1.74	.246	.376
Manganese	5		7.42	.121	
Mercury	95.8	.00089	13.59	.033	.015
Molybdenum	5.08 at 0	.0047 (0–100)	9.0	.065	.346
Monel metal	42	.002	8.9		.062
Nickel	7.8	.00537 (20–100)	8.9	.105	.142
Platinum	9.83 at 0	.003	21.4	.0324	.166
Potassium	6.1 at 0	.0055 at 0	.851	.19	
Silver	1.629 at 18	.0038	10.5	.056	1.0
Sodium	4.3 at 0	.0054	.951	.295	
Steel (soft)	11.8	.004	7.7	.118	.115
Steel (hard)	45.6	.0016	7.7	.118	.115
Steel (nickel)	30–85	.0007	7.7	.118	.115
Tantalum	15.5	.0031	16.6	.036	.130
Thallium	17.6 at 0	.0040 at 0	11.86	.038	
Thorium	18	.0021 (20–1800)	11.5	.027	
Tin	11.5	.0042	7.3	.054	.155
Tungsten	5.5	.0047 (0–100)	19	.034	.476
Zinc	5.75 at 0	.0037	7.1	.093	.265

Note: Data compiled by Industrial Electronics Div., Westinghouse Electric Corp., Baltimore, Md.

engineers and builders of oil hydraulic equipment

Since 1921



Vickers has been developing, improving and manufacturing oil hydraulic equipment since 1921 . . . five years before Lindbergh flew the Atlantic. In the 24 years that we have been building and applying hydraulic pumps and controls, our organization has accumulated a background of experience that has been invaluable in reaching the correct solution to many difficult problems in aircraft hydraulics.

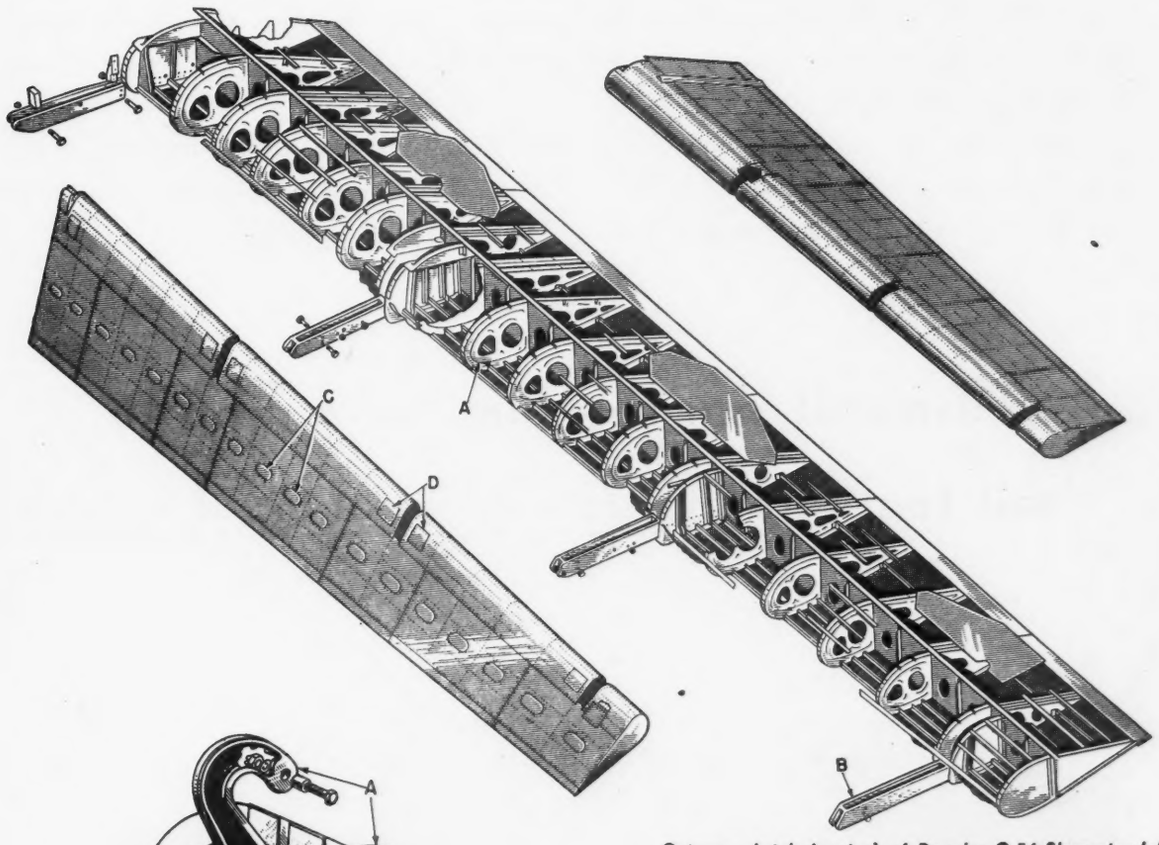
Today, Vickers has the most extensive line of aircraft hydraulic pumps and controls . . . is the country's largest builder of precision oil hydraulic equipment.

Vickers Incorporated is entirely American-owned and has never been a subsidiary of, or associated with, any foreign company.

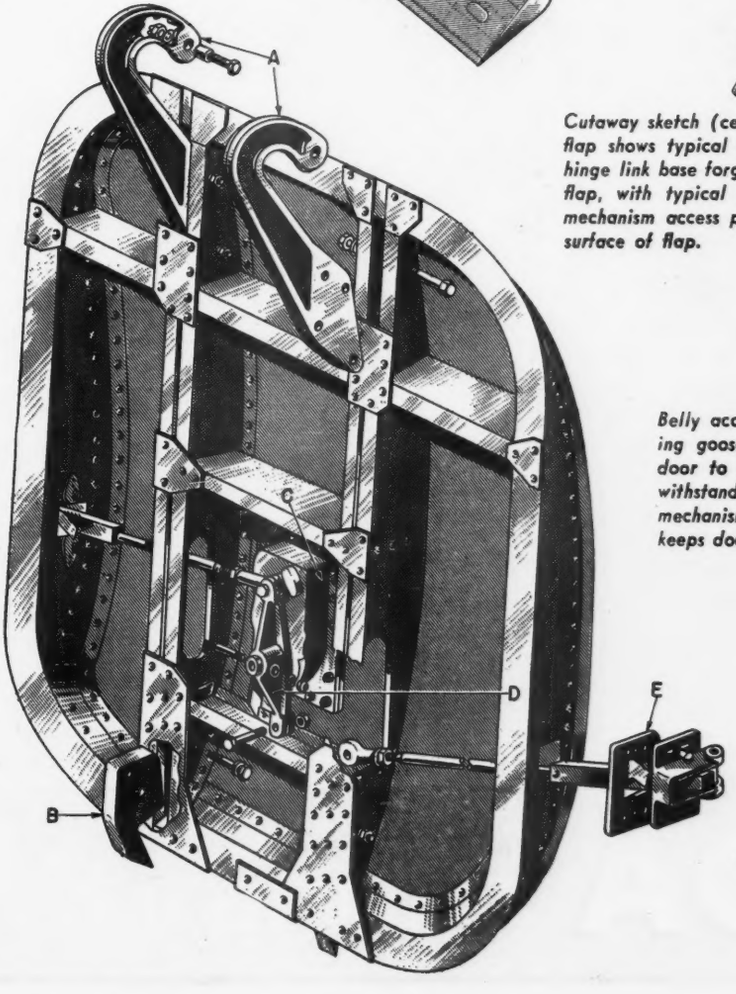
"Hydraulics" has been our business since long before the war began . . . it will continue to be our principal business.

VICKERS Incorporated

1462 OAKMAN BLVD., DETROIT 32, MICH.



Cutaway sketch (center) of Douglas C-54 Skymaster left wing flap shows typical deep drawn rib (A) and aluminum alloy hinge link base forging (B). Sketch at left shows lower skin of flap, with typical inspection plates at (C), and hinge link mechanism access plates at (D). Sketch at right shows upper surface of flap.



Belly accessory compartment door of C-54, revealing gooseneck hinges (A) to allow double curved door to swing up against ceiling, stop (B) which withstands cabin pressure, door lock (C), latch rod mechanism (D), and adjustable latch plate (E) which keeps door in locked position.

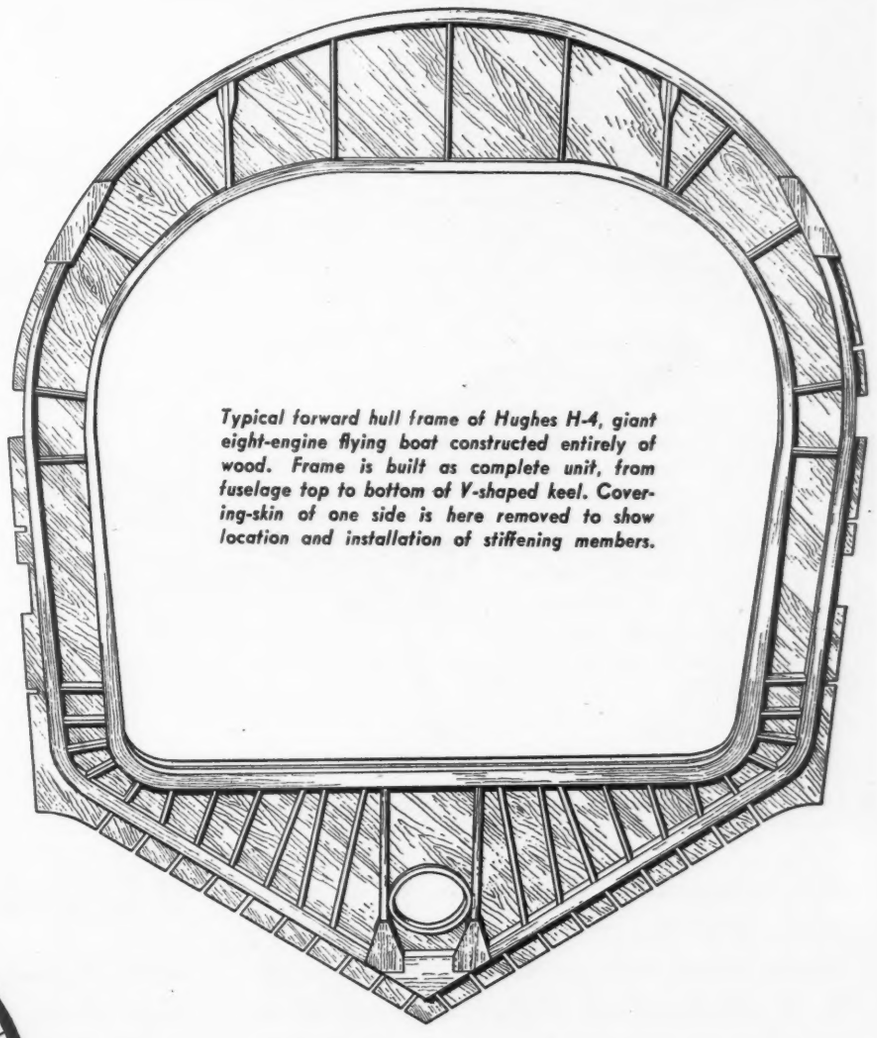
PERSONAL plane salesmen have a powerful, convincing story on all-metal, aluminum construction. Low up-keep cost, more maintenance-free flying hours, greater re-sale value and high factors of safety are points airplane buyers will spark to.

Alcoa has the alloys to support those sales points in every detail. In addition, these alloys offer lightness and strength, sleek and swift appearance—and public acceptance as a highly airworthy material.

Alcoa Aluminum Alloys have done yeoman service on our warplanes. Let our engineers help you determine where you can use these alloys to best advantage in your personal planes. For this information simply write ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

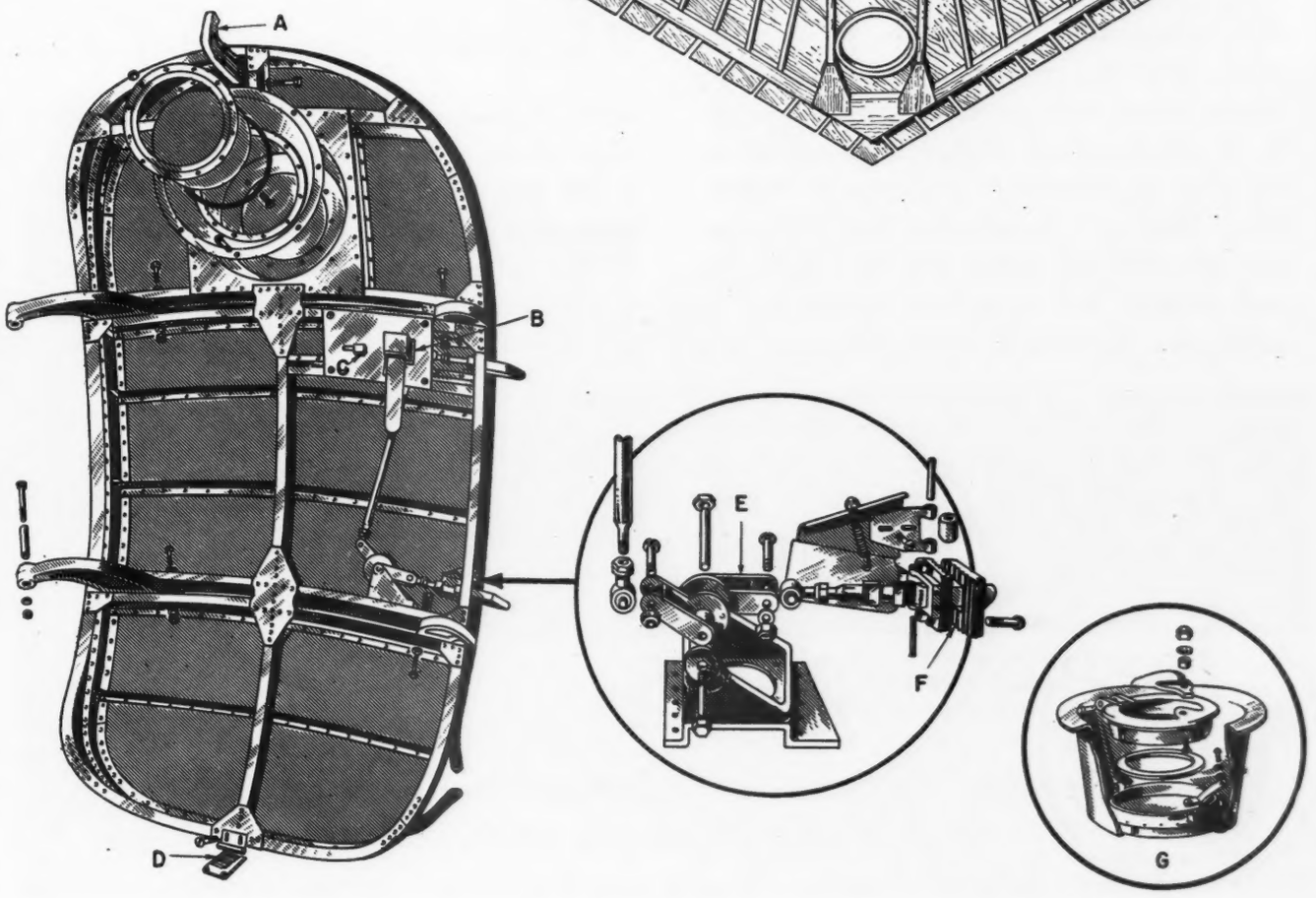
"All-metal construction, from prop to tail feathers... Alcoa Aluminum, of course!"

ALCOA FIRST IN ALUMINUM



Typical forward hull frame of Hughes H-4, giant eight-engine flying boat constructed entirely of wood. Frame is built as complete unit, from fuselage top to bottom of V-shaped keel. Covering-skin of one side is here removed to show location and installation of stiffening members.

Below: Douglas C-54 pilot entrance door, with lining removed showing stops (A) to withstand internal cabin pressure, door lock (B) with safety latch (C), and adjustable serrated door-open stop (D). Circled sketch at center shows door-locking wedge mechanism (E) with serrated adjustable latch plates (F). Circled sketch (G) shows small service door located by each main door for electric cords, vacuum and air hose, or other ground service facilities.



The Preference is for Berryloid

What was good enough prewar isn't good enough today. There is a new scale of values in aviation finishes. New discoveries and new techniques have made Berryloid tougher, more resistant to all kinds of weather and climatic conditions. Berry Brothers' research has brought a new conception of color-styling that has added a new and different "eye appeal" to planes now in production. Now that Berry Brothers can again serve peacetime aviation, it is applying the knowledge and skills developed from wartime service to the Army and Navy to making even better finishes for private and commercial flying. After 30 years of service to manufacturers and owners of America's quality planes, Berryloid is enjoying an ever-increasing preference in aviation finishes.

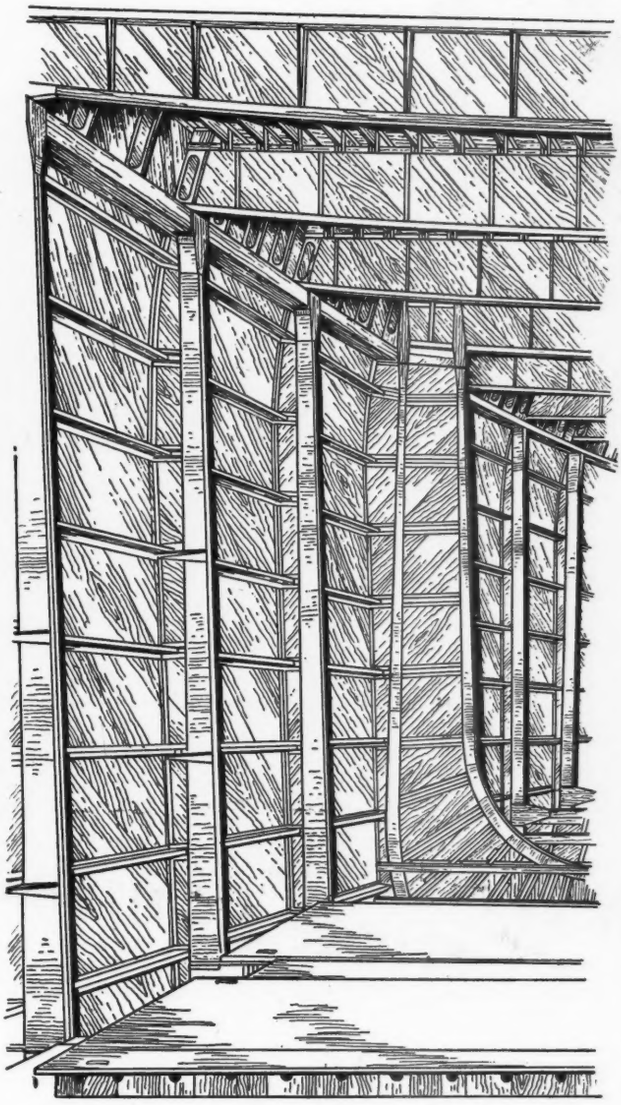
BERRYLOID
AIRCRAFT FINISHES

Berryloid Aircraft Finishes
BERRY BROTHERS

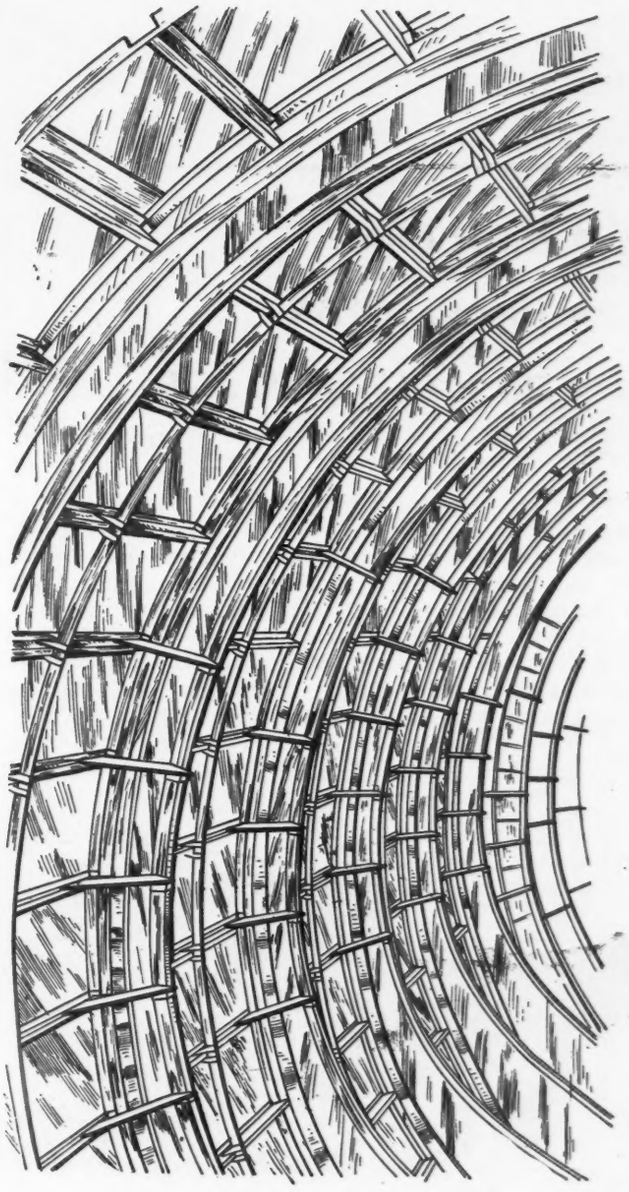
BERRY BROTHERS
Paints · Varnishes · Enamels · Lacquers
Detroit 7, Mich. Walkerville, Ont.

Leading Producers of Aviation Finishing Materials in War and Peace, for over 30 Years

BOSTON • JERSEY CITY • CINCINNATI • CHICAGO • ST. LOUIS • INGLEWOOD, CALIF. • MONTREAL • WINNIPEG • TORONTO

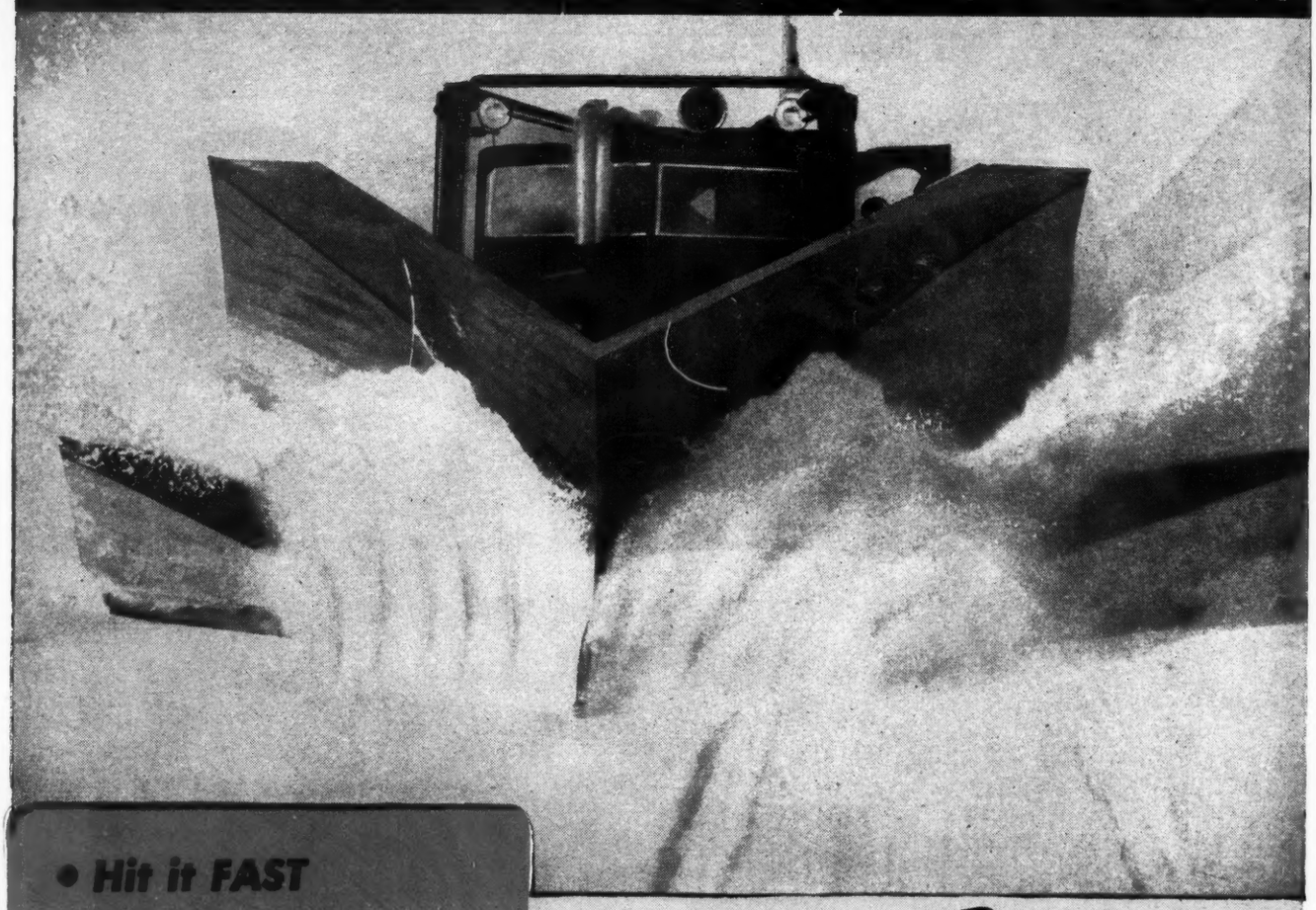


Detail sketch showing construction inside fuselage below flight deck of Hughes H-4. Flooring in foreground covers 14 fuel tanks of 1,000-gal. capacity each.



Sketch at right shows construction of former rings, stringers, and gussets in H-4 at point 166 ft. from nose.

DON'T GIVE SNOW A CHANCE!



- **Hit it FAST**
- **Throw it FAR**
- **Do a CLEANER JOB**

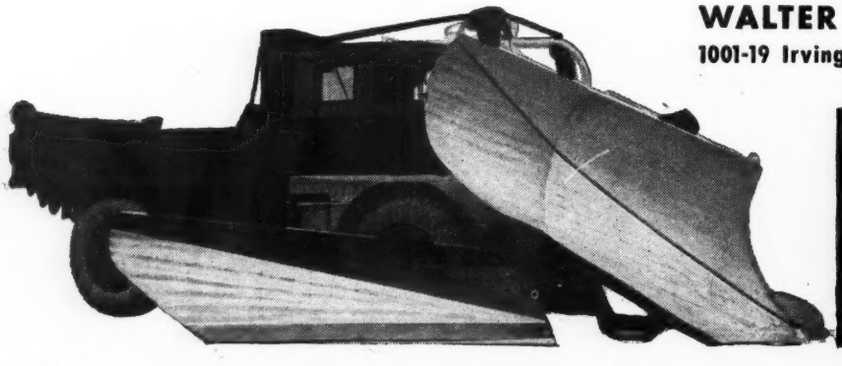
with WALTER SNOW FIGHTERS

The faster your snow clearance, the less chance for snow banks, icy ruts and deep drifts to imperil landings and takeoffs. Walter Snow Fighters keep *ahead* of any storm, holding schedule interruptions to a minimum. Making full use of their 28 ft. plow and wing span, they shuttle over the runways at 30 m.p.h. This high-speed clearing action throws snow far out—gives thorough dispersion—leaves less to handle on subsequent runs—makes cleaning up easier.

Such sustained high speed clearance is possible *only* with Walter Snow Fighters because of the 100% traction provided by the Four Point Positive Drive. There is no wheel spinning, slipping or stalling on snow or icy surfaces. Steady tractive power is available at all times.

Walter Snow Fighters have greater clearing capacity, thus fewer units do a more effective job, cutting your equipment, maintenance and snow removal costs. Have one of our snow removal experts discuss your needs. Write for detailed literature today.

WALTER MOTOR TRUCK COMPANY
1001-19 Irving Avenue, Ridgewood 27, Queens, L. I., N. Y.



WALTER SNOW FIGHTERS

ENGINE-STOCK POSITION STRONGER THAN MARKET INDICATES

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

Although power plant builders generated tremendous war surplus, investors appear to be over-fearful of probability that we will have recurrence of World War I's engine hangover that killed development so many years.

MOST SIGNIFICANT CHANGE in stock market appraisal of the aircraft industry last year was the relative unpopularity of aircraft engine stocks. Time was when such well established engine makers as United Aircraft and Wright Aeronautical were top investment favorites in the aircraft field. But the trend of favor today is more in the direction of the airframe group.

For a 10-yr. period, from 1935 to 1944, according to the price index chart compiled by John H. Lewis & Co., New York brokerage firm specializing in aviation stocks, stock market prices of the engine and airframe companies fluctuated almost equally. Last year, however, the airframes did better than twice as well as the engine manufacturers marketwise. What was the reasons for the backwardness of the engine makers?

The war surplus situation for aircraft engines probably is one compelling reason why the engine makers have lost some of their market appeal. There are still a lot of present-day investors in and out of Wall Street who remember the glut of Liberty and OX-5 engines that continued long after World War I.

Knowing that nearly 700,000 aircraft power plants were produced during the recent war and that perhaps 100,000 new engines were still in their cellophane wraps on V-J Day, it's no wonder that investors quickly became concerned over surplus engine stocks. While the public took it for granted that combat planes would hit the scrap piles, it was felt that wartime engines would be usable for some time hence.

However, it seems to us that the surplus engine picture, serious as it is right now, has been over-played as a stock market factor. Certainly the outlook in this respect is not quite as bad as it appeared a few months ago. Nor is the situation parallel to the Liberty and OX-5 engine case—for this reason: Unlike the last postwar engine days, the taxpayers and their Congressmen are fairly well educated today in the matter of obsolescence. After the other war the nation turned all thought and effort to peacetime pursuits.

Today things are far different and the nation has daily reminders in the cables from abroad and from our scientists of the need for continually improving our defense position. There is general acceptance of the dictum that our military aircraft became obsolete the day the war ended.

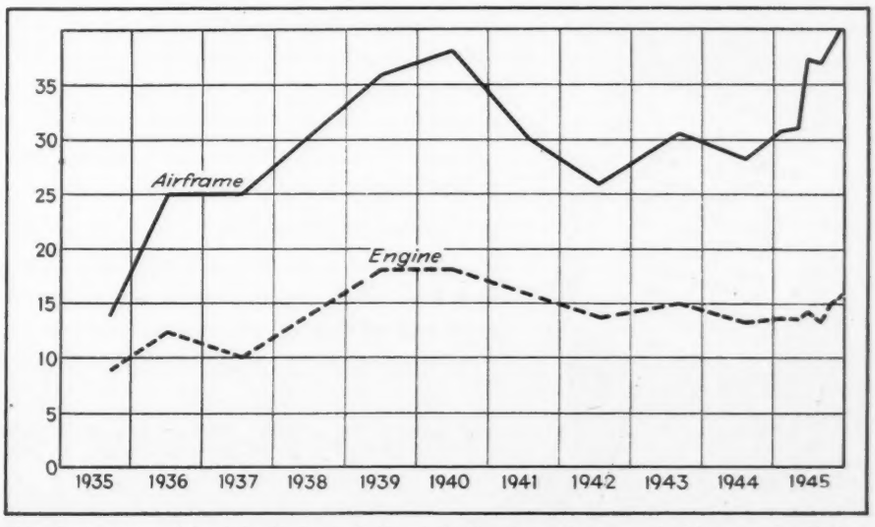
The airlines, too, have reason to be demanding the latest thing in power plant equipment. They have cut their mail, passenger, and freight rates within the last 12 mo. They aim to maintain their high wartime level of profits, however, through greater volume and efficient operation.

Naturally they want engines improved over those in wartime use, and they are already buying hundreds of the newer models. Soon they will have no part of any wartime surplus. So the investor should exercise caution in considering the present surplus problem as more than a temporary bearish argument against the power plant securities.

Another current argument against the engine stocks is the matter of sharply increased competition. For many years Pratt & Whitney (United Aircraft) and Wright Aero (Curtiss-Wright) had the aircraft engine field pretty much to themselves, except in the smaller engines. Later on, Allison (General Motors) made it a threesome.

Today, however, this small group of engine makers faces strong future competition—with turbojet markets coming

(*Turn to page* 187)



This chart, prepared by John H. Lewis & Co., tells the story. Engine and airframe price fluctuations were almost parallel for 10 yr., then last year airframe securities gained more than twice as much as power plant stocks.

NO MATTER WHAT YOUR PRODUCT MAY BE . . .

Ex-Cello's Complete Parts Production Facilities May Be of Practical Help to YOU!

Few people realize how extensive are Ex-Cell-O's facilities for the speedy production of quality parts. Yet the same wide experience, the engineering "know-how", and the outstanding accuracy that distinguish Ex-Cell-O machine tools and cutting tools wherever they are used . . . in many parts of the world . . . go into Ex-Cell-O's production parts manufacture.

If your product requires carefully machined parts, the chances are Ex-Cell-O can work with you to your economical advantage. Contact Ex-Cell-O today, either at the Head Office in Detroit or through any one of the 27 other leading industrial centers where Ex-Cell-O field engineering representatives are located.

Folder illustrating Ex-Cell-O's complete parts production facilities will be sent you upon request. Write or wire Ex-Cell-O today and ask for Ex-Cell-O Bulletin No. 36151.

EX-CELL-O CORPORATION • DETROIT 6

XLO

EX-CELL-O *for* PRECISION

SIDE SLIPS

THE MORE WE STUDY turbojets the more we realize that the intake end can be just as nasty as the exhaust end. There was, for example, the test engineer who got a little too close and found himself glued to the front end. His overcoat had a patch pocket, the patch pocket contained a metal box full of pills, and quicker than a rabbit both patch pocket and medicine got the business—right through the compressor, combustion chamber, turbine, and all—but the engine kept on going. Man on the control panel, they found out later, wrote meticulously, "Note slight deterioration in performance, shutting down to investigate." When the rest of the crew found that statement they were sorely tempted to note, "Cough medicine in pill form has been found to be bad medicine for this engine."

• No, Dr. Fetoofnick, Rotary International is not a new helicopter company.

• Judging from several war tales told by the photo recon experts, film interpretation was only half the story. Rest of the knack lay in what you might call inspired disbelief of the said interpretations. Case in point is related by F/O Constance Babington-Smith, the winsome British WAAF credited with putting the photo-finger on Adolf's V-1 buzz-bomb.

One group of photo interpreters, it seems, had simplified the routine "what-is-it" job by devising a handy "working diameter" for use in identifying enemy oil tanks. And this was swell—until one day the bomber boys were only stopped at the last minute from blasting a shower of wooden-horse anatomy over a certain section of Jerry countryside. Somehow, a German carnival equipment company had specified that same top diameter for its merry-go-rounds.

Another instance is told by a U. S. photo recon man whose sphere of operations was mountainous North Italy. Lads of his outfit were bothered no end by a road which had suddenly appeared in the newly-snow-covered heights. The film showed it to be a mighty well traveled road, yet it appeared to lead nowhere. "That means, they decided, "that some important underground installation lies at the end of the cryptic thoroughfare. B'gosh, we'll pound it to hell."

But then the inspired skeptic stepped in. "Lets," he said, "take just one more look first." So they did. And this close-up showed what the well-traveled road-to-nowhere actually was—a German officers' new toboggan run.

• So you're going out to the airport and buy yourself one of those brand new postwar planes—just like you could buy a nice new auto once upon a time. List' ye well, then, to this one:

There were 25 new planes ready for fly-away delivery, except for one little item, the radios. The radios were ready, too—except for one little item, one tube per each. So, naturally, both the aircraft producer and the radio manufacturer ripped through the usual sources for those particular units, but to their surprise, it was no soap, account of these items were very scarce. They finally got the tubes, though, but only after the radio man had dispatched 171 telegrams, written 33 oh-so-ardent letters and made 52 phone calls.

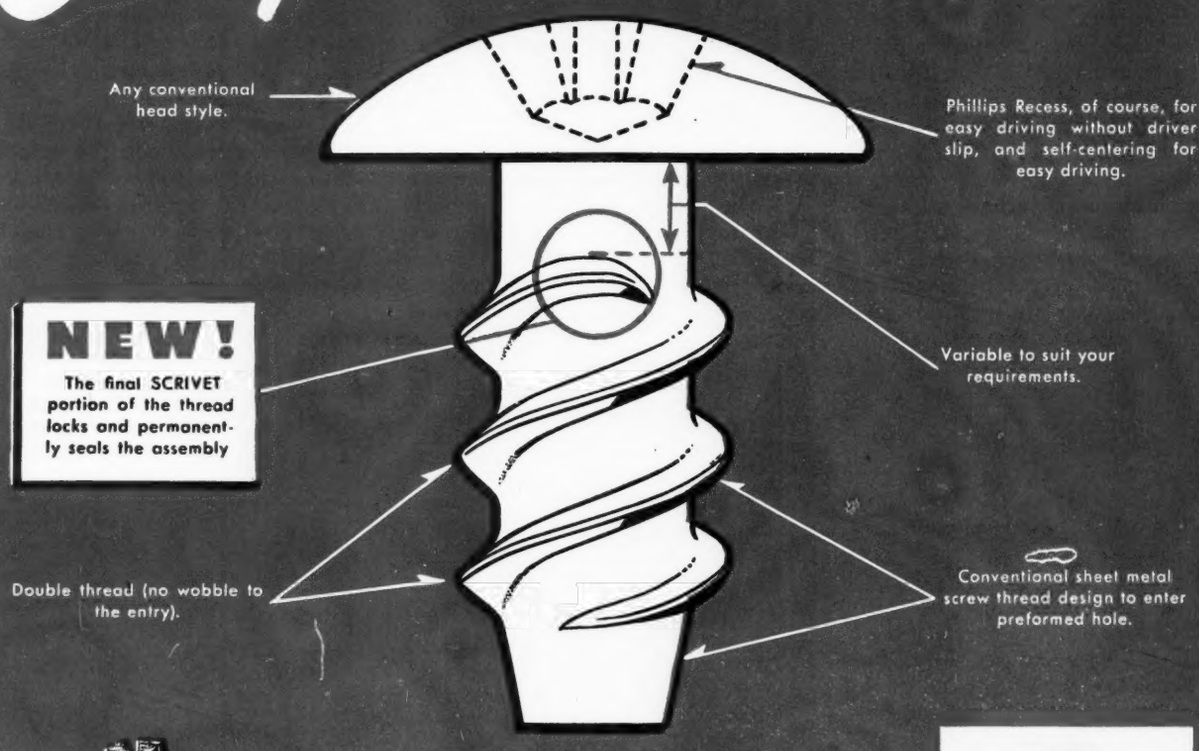
What pleased him most was the fact that he was able, in one lone instance, to satisfy the operator's behest to "Limit your call to four minutes, pul-lease."

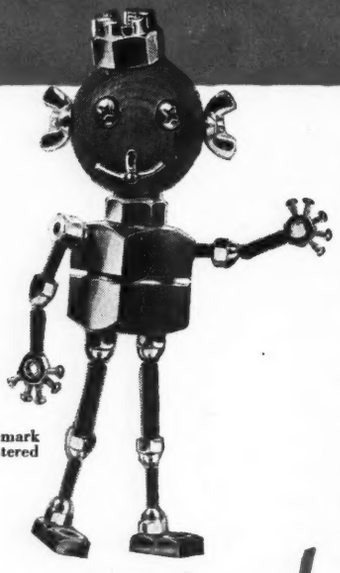
• What we thought was one of the longest reconversion jumps on record was that of a pessimistic acquaintance who's gone from aeronautics to selling perfume. 'Twasn't such a long jump at all, he maintains, "just from one smell to another."

• Now it's movies on transoceanic planes. Wonder who'll be the first guy to lurch sleepily to his feet and start for the exit muttering, "This is where I came in."

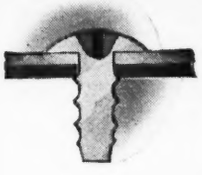
"Maguire thinks he'll get fees from all those aircrews we won't need for the planes we won't use in the war we're not going to have."

Can you use SCRIVETS?


Any conventional head style.
Phillips Recess, of course, for easy driving without driver slip, and self-centering for easy driving.
NEW!
The final SCRIVET portion of the thread locks and permanently seals the assembly
Variable to suit your requirements.
Double thread (no wobble to the entry).
Conventional sheet metal screw thread design to enter preformed hole.



Trademark Registered



Sectional view of SCRIVET in use, showing simplest application, fastening two sheets permanently

SCRIVETS* are a new and important development in the fastening field. A sort of combination screw and rivet, the SCRIVET is driven like a screw, but it locks and can't come out. Ideal for easy, rapid and permanent assembly.

1. Holds together *permanently* any two parts or sections.

2. Replaces sheet metal screw which might work loose (the SCRIVET has better holding power than a screw).

3. Replaces rivet which is often difficult or impossible to apply in close quarters. (The SCRIVET has not quite as good holding power as a regular rivet. Holds better than a blind rivet and costs much less.)

If you see possibilities of making good use of SCRIVETS on your work, let us hear from you. We'll gladly send samples and design a SCRIVET for your special requirements.

National HEADED AND THREADED PRODUCTS

**Trademark registered. Patent Nos. 2321378, 2321379, 2353030*

THE NATIONAL SCREW & MFG. CO., CLEVELAND, O.

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

Decision on Service Merger Still Awaited, But It's Expected AAF Will Win Equality

. . . Gage '46 scrap total . . . Five-step Arnold plan . . . See tightening of N-S . . . Airport program knotted . . . Fog dispersal angles . . . Report RCM data . . . List 70 surplus fields. . . . Six lines still ATCing . . . May move plants inland . . . AAF will keep Muroc.

Unified command for Army and Navy still faces a hard battle, with the outcome in doubt. In addition to military considerations, politics are heavily concerned. President Truman's stand favoring the action will be a strong influence in the decision.

But even if failure ends the effort to put Army and Navy under a department of defense, it is probable that Air Forces will be given equality with ground and sea forces.

Strong opposition to unification of armed forces has come almost entirely from the Navy, which contends that the merger would be equivalent to absorption of Navy into the Army. Sec. Forrestal has advanced one argument after another against the move.

Latest Navy gesture for independence is the Secretary's announcement that aviation officers will hold half of the high posts under the chief of naval operations, and will be assigned for the first time to fleet commands.

Since the Navy has come to be regarded as a seaborne air force (though many of its officers do not concede as much) it is probable that Navy will retain its air arm, which is now said to be larger in point of tonnage and personnel than all capital ship strength combined.

Gage '46 Scrap Total

About $9 billion worth of surplus warplanes will be scrapped by RFC and SPA within the next 12 mo. All useless combat planes, they are being disposed of at the rate of $8 million per day. SPA decided to go ahead, risking any future resentment by the public, which might regard the salvage as uneconomical destruction.

Disassembly fields are at Walnut Ridge, Ark.; Altus and Clinton, Okla.; Kingman, Ariz.; Augusta, Ga.; and Ontario, Calif. Eventually more than 40,000 planes will be dismembered at these places. In all 117,210 planes and 72,400 engines will be surplus by June, SPA said. Valuable instruments and accessories, armament, radio, tires if good, are removed, and the body is crushed flat with a big tractor.

One B-24 yields about 13,000 lb. of aluminum which, however, is not pure. Its value is being investigated. Because metal resources have been seriously depleted, the saving of scrap, even at costs higher than the market price, is urgently recommended by many authorities.

Five-Step Arnold Plan

Gen. Arnold recently stated that the atomic bomb made the air fleets of World War II "as outmoded as the Macedonian phalanx." U. S. air supremacy, he wrote in the *Army and Navy Journal*, "may prove to be as hollow as the legend of the Maginot line," if Americans become complacent.

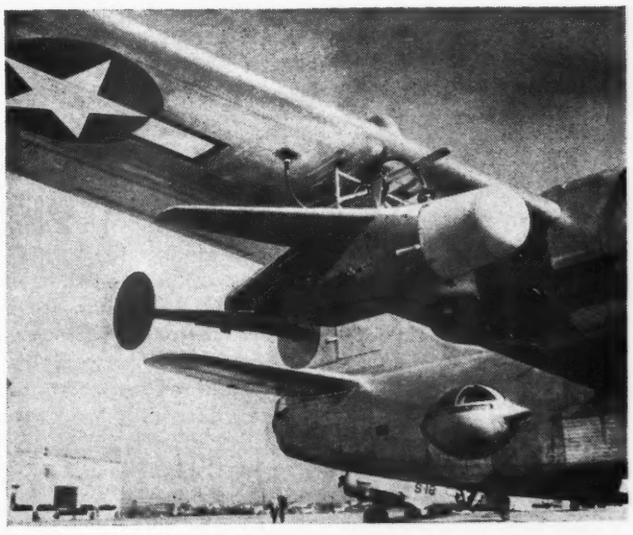
The General said we must maintain: (1) An up-to-the-minute air force; (2) a nucleus of trained men for rapid expansion; (3) research and development to make our fighting equipment the best in the world; (4) a strong industry capable of rapid expansion and production; and (5) strategic bases.

In his report to the Secretary of War, he said planes with jet or rocket engines would carry 50 tons of bombs around the world at supersonic speed.

See Tightening of N-S

Hearings on CAB's plans to exercise controls on nonscheduled air transport have been concluded, with the service operators objecting strongly to the proposals. But the Board, upon advice of its examiners, and considering its obligations under the Act, seems inclined to tighten its control.

To do so, the Board would revise the order of 1938 which exempted service flying. Operators would be required to register, set limits on some trip frequencies, observe additional safety regulations, and file reports. Direct and regular competition against scheduled carriers would be prohibited. The Board feels that control will protect service operators from irresponsible competition and will provide them with legal standing before the public.



NAVY BAT WHICH WALLOPED JAP SHIPS

Closeup of Navy Bat-Bomb flying missile, shown slung under wing of a Convair PB4Y-2 Privateer. It was recently disclosed that these 12 ft.-long bombs—launched from Privateers while outside range of enemy A-A fire and guided to targets by radar—destroyed many tons of Jap shipping during last year of war. Patrol planes carried one beneath each wing. Power plant of missile has not been revealed, but it is probably a rocket type. (Press Assn. photo)

Airport Program Knotted

Senate - House conference committee was in disagreement, at this writing, on several points of the federal aid airport construction program, recently passed by both houses. It seemed likely that they would agree on the sum of $700,000,000 to be spent over a period of 7 yr. But they disagree on the question whether to channel funds through state governments only, or whether to authorize direct dealing between municipalities and Washington. This was the chief controversial point in committee and floor action.

Indications were that federal funds would be matched 50–50 with local funds for Class 1, 2, and 3 fields, and in

COMING UP

Jan. 4 - 6. All-American Air Maneuvers. Florida Air Races, Miami.
Jan. 7-11: SAE Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit.
Jan. 8: IATA North Atlantic Rate Conference, New York.
Jan. 11-20: Cleveland Aircraft Show, Public Auditorium, Cleveland.
Jan. 21-22: Northwest Aviation Planning Council, Boise Hotel, Boise, Ida.
Jan. 28: IAS Honors Night Dinner, Waldorf-Astoria Hotel, N. Y. C.
Jan. 29-31: IAS Annual Meeting, Pupin Laboratory, Columbia University, N. Y. C.
Feb. 4-7: American Welding Society National Meeting, Hotel Cleveland, Cleveland.
Feb. 4-8: National Metal Exposition, also National Metal Congress, Public Auditorium, Cleveland.
Feb. 4-8: American Society for Metals' postponed 1945 Annual Convention, Statler Hotel, Cleveland.
Feb. 4-8: American Institute of Mining & Metallurgical Engineers, Iron & Steel and Institute of Metals Divs. National Meeting, Statler Hotel, Cleveland.
Feb. 12: IATA European Rate Conference, Paris.
Feb. 21: IATA Middle East Rate Conference, Cairo.
Mar. 1-5: Pan American Aircraft Exposition, Dallas.
Apr. 3-5: SAE National Aeronautic Meeting, Hotel New Yorker, N. Y. C.
May 7-9: National Assn. of Corrosion Engineers, Annual Meeting and Convention, President Hotel, Kansas City, Mo.
July 19-20: NAA National Convention, Omaha, Neb.

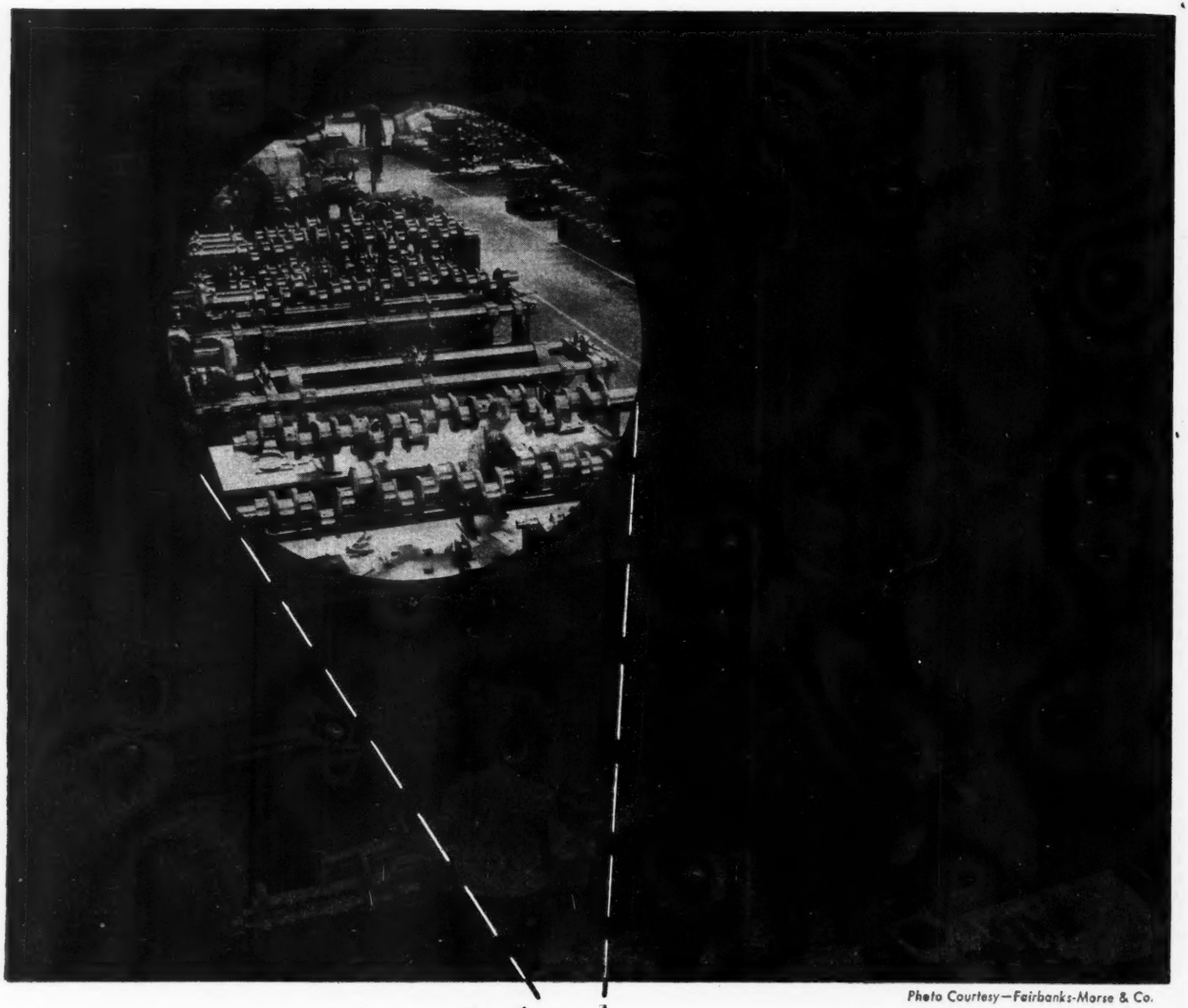


Photo Courtesy—Fairbanks-Morse & Co.

it's OLSEN for Balancing at Fairbanks-Morse . . .

Diesel engine crankshafts, produced at the Beloit plant of Fairbanks-Morse & Co. are balanced by Olsen Type "S" dual compensating balancing machines shown above.

Every shaft is dynamically balanced. The direct reading compensators indicate the angle and amount of unbalance in the planes in which corrections are to be made. The Olsen cradle type design permits multiple support to these lengthy shafts (up to 12 feet) thereby eliminating deflection difficulties.

The use of Olsen Balancing Machines has made it possible to effect substantial savings and increase production in this Fairbanks-Morse plant.

Olsen equipment reduces costs and improves products. Write today describing your problem.

TINIUS OLSEN TESTING MACHINE CO.
560 NORTH TWELFTH STREET, PHILADELPHIA 23, PA.
Balancing Machines AND PHYSICAL TESTING EQUIPMENT

Representatives: **PACIFIC SCIENTIFIC CO., Los Angeles, San Francisco, Seattle**
MINE and SMELTER SUPPLY CO., Denver, Colo.

THERE IS AN OLSEN BALANCING MACHINE TO BALANCE ANY ROTATING PART...
FROM MINIATURE MOTOR ROTORS TO PARTS WEIGHING UP TO 25,000 POUNDS

the case of smaller fields the division would be discretionary. Signature by the President is likely early in 1946.

Fog Dispersal Angles

Navy is continuing the long battle to disperse fog at landing fields. Most promising method, improved by the British during the war, is the generation of heat, chiefly with oil burners placed along the runways. Tests at Arcata, Calif., indicate the cost may be reduced to $200 per landing.

At such cost, this procedure would seem limited to military, but air transport is interested. Several airlines, especially those operating big planes on long trips, might call the expense permissible.

Other methods for dispersing fog: Intense sound, to coalesce droplets; water screens thrown up by pressure; hot air curtains; and projection of desiccants which precipitate water particles.

Report RCM Data

AAF reveals that by V-J day about 40 different types of radar counter-measure devices, totaling more than 60,000 units, had been furnished overseas commanders. During the first 6 mo. of 1945, $55 million was spent on RCM gear. Search and intercept receivers hunt out enemy radar, analyzers define it, and transmitters jam it. The enemy is deceived by bundles of aluminum foil released in the air.

List 70 Surplus Fields

Surplus Property Administration has released a list of 70 military airports declared surplus. It is estimated surplus airports will total 400 or so. SPA law says all must be offered for sale or lease to states or other local governments. RFC is the disposal agency, but CAA is consulted.

Six Lines Still ATCing

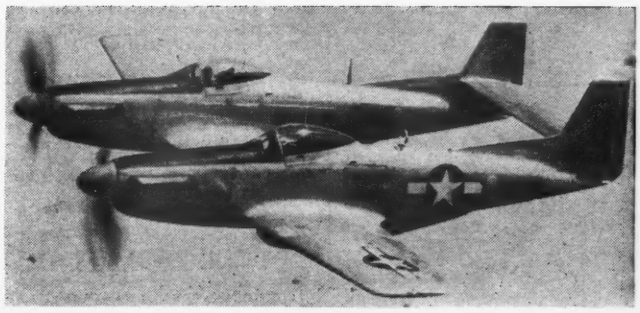
Only 6 of the 20 commercial carriers who contracted services to ATC during the war are still operating under contract. The services of the six have been considerably curtailed, and will be terminated next March. The six are: AA, AOA, Northwest, PAA, TWA, and UAL.

CAA believes the worldwide ATC facilities should be used in peacetime air transport. CAA experts, after a 37,000-mi. inspection trip, recommend that the U. S. obtain control of many foreign landing areas and associated facilities.

May Move Plants Inland

Air Forces has plans, so far informal, for removing some of its airplane production inland from the congested Los Angeles area. A previous plan of the inter-departmental Air Coordinating Committee was to keep commercial production in "home" plants and shift military work to the interior.

AAF has ideas concerning each of the several companies and plants, but they are tentative, pending further study of the value of underground installation, plus an attempt to forecast the potentialities of weapons with which this country might be attacked.



BUILT-IN WINGMAN

Looking like an optical illusion, NAA XP-82 Twin Mustang, one of AAF's latest fighters, packs meanest wallop in its class, 6 to 14 .50-cal. guns, 25 rockets, four 1,000 lb. bombs. Designed for long range escort work, plane is essentially two P-51s joined at center section. Pilot and co-pilot sit in separate cockpits, each fitted with disengaging pedals so that either man can stretch out in special adjustable seat, and relax while other takes over. Two Packard Rolls-Royce 2,200-hp. engines give a top speed of more than 475 mph., over 5,000 fpm. climb, and 45,000 ft. ceiling. Range is over 3,000 mi. (Press Assn. photo)

AAF Will Keep Muroc

Muroc Dry Lake experimental center, established in July 1942, will be AAF's permanent Flight Test Base. Reported to be the world's largest natural landing area, the hard smooth lake bed is 7 mi. wide by 12 mi. long. For decades before the war it was used by auto racers and civilian plane and glider builders. Many of the great airplanes of the war just ended were tested on it.

Collier Trophy to Spaatz

For demonstrating air power concept through employment of American Aviation in war against Germany, Gen Carl A. Spaatz has received Robert J. Collier Trophy for 1944. Presented by Pres. Truman on behalf of NAA, award was first given for purely combat achievement.

★ SPOT CHECKING ★

Fully-loaded Republic P-47N Thunderbolts were flown from decks of Navy CVE carriers to assist in capture of Saipan in June of last year. P-47Ds were successfully launched from carriers on June 20, 1944.

In carrying out General Tire & Rubber Co. assignments during war, executives traveled 773,635 mi. by air in comparison with 100,000 mi. of rail travel.

Underwriters of more than 80% of life insurance in U. S. now consider global air travel as standard risk, with another 10% accepting limited travel of about 50,000 mi. as standard.

Study of Boeing C-97 Stratocruiser as flying ambulance, made by company on hypothetical 8,000 mi. run, shows that one such craft could carry over 700 patients monthly across Pacific from Manila to Los Angeles. Capacity would be 53 litter and 49 ambulatory patients, or 83 on litters.

Personal flying between nations of Western Hemisphere has been eased by recent CAA order authorizing agency's border inspectors to issue permits for flights by foreign civil planes. Previously permission could only be obtained from Washington. Only restriction is that craft do not carry mail or fly passengers or cargo for hire. Purchasers of new planes may also obtain permits from CAA factory inspectors to fly them through and out of U. S.

Believing that number of planes in non-scheduled operations this year will double those in '45, Aero Insurance Underwriters is promulgating entirely new liability schedules lowering aircraft insurance rates as much as 50%.

Loan of helicopters and preparation of a course on rotary wing science has been arranged for Miami Tech High School by Southeastern Research, 719 Congress Bldg., Miami, headed by Albert A. Green. It is stated that school's facilities are available to those manufacturers interested in testing equipment on helicopters.

Half total surplus expected by June will consist of aircraft and parts originally costing government over 17 billion dollars. More than 15,000 planes have been sold for over $31,000,000.

G-E's I-40 turbojet has been installed by company in a Convair B-24 Liberator flying laboratory. Use of "flying test cell" allows room for engineers to observe operations under flight conditions, and investigate problems and accessories at considerably less cost and greater availability than in wind tunnel.

Publications: "Recommendations on National Aviation Policy" and "White Elephants With Wings" are new AIA booklets. Former (priced at 10¢) is report by National Planning Committee based on study of military and civil aviation by selected leaders from government, industry, labor, education, and armed services. Latter booklet, available to AIA members, deals with problems of surplus aircraft disposal. . . . "Let's Keep America Strong in the Air" is Convair offering stressing need for continued research and strong air arm. . . . National Aviation Clinic is making available copies of resolutions adopted at recent Oklahoma meeting. These may be had by writing clinic hq., c/o Oklahoma City C. of C., Oklahoma City, or NAA at 1025 Connecticut Ave., Washington (6) D. C. . . . "Manual of Procedure under Government Contracts" provides information to firms interested in, or now supplying, goods or services to government. Gratis copies are obtainable from Fidelity & Deposit Co. of Maryland, Baltimore. . . . Joint Board on Scientific Information Policy has released "Electronics Warfare," a report on radar countermeasures. . . . "Air Transportation, Yesterday, Today, and Tomorrow" is ATA report on pattern of domestic airline service, with statistics on nationwide operations and traffic.

Utilizing a new type of outdoor rig, Lockheed engineers recently completed a 3,500-hr. stress test on Constellation wing. Test loads of 50 tons were applied, and conditions approximating flights at 350 mph. were achieved. Wing tests are expected to extend through 25,000 hr.

Record flights: Same Boeing Superfortress that recently made 8,193-mi. nonstop Guam-Washington flight in 30 hr. later hopped across U. S. from Burbank to N. Y. C. in 5:27:8. Latter nonstop 2,464-mi. flight was made at an average speed of better than 450 mph., besting all previous official marks. Several days earlier, Douglas XB-42 raced nonstop from Long Beach, Calif., to Washington, D. C., covering 2,290 mi. in 5:17:34.

Possibilities of forced landings in commercial overseas travel have been reduced to nearly zero, according to Frank R. Canney of Boeing. In a recent SAE talk he estimated probable frequency of such ditchings as one in 16,576 flights. Noted was fact that in B-29 operations, ratio was 1:750,000 mi. of flying.

NYU's spring term, starting Jan. 28, will offer new course in Applied Aerodynamics, open to students who have had undergraduate equivalent of aerodynamics course, or who have engineering bachelor's degree. To be given by Ralph H. Upson, course will embrace much material not now available in textbooks.

Survey by Aero Training Society shows aviation is leading occupation preference of servicemen by 31% count, legal profession being second with 7% vote. Of those looking to aviation careers, 29% seek to enter aero engineering, 22% aspire to be mechanics, 21% desire to become commercial pilots, and 28% are variously interested in aero radio, air photography, meteorology, or other phases. Plane ownership is anticipated within next few years by 36% of total group, 10% saying they wish to buy a craft "as soon as possible." Most expect to make an outlay of between $1,500 and $2,000 for their craft.

New Lockheed P2V Neptune, Navy land-based plane, is stated to have more range (5,000 mi.), speed (over 300 mph. top), and armament than any scout bomber. Craft is fitted for torpedoes, rockets, bombs, depth charges, cannons, and guns, and latest radar equipment is used. Two Wright 3350s drive Hamilton four-bladed propellers.

FLYING SALESMAN MAKES OWN SCHEDULES

Thomas F. Hale, Jr., (right), v.-p. of Pathescope Co., maker of industrial training films and slides, recently scored a first for his industry by inaugurating company's use of chartered airplanes to reach localities which scheduled flights do not serve. Thus speeding conferences and service for clients, idea has proved advantageous, and Pathescope now intends to expand charter plan to include production-location trips.

★ CALLING NAMES ★

Comdr. Walter H. Neff, in charge of aviation section of Navy public relations and asst. director of public information program, will rejoin PAA.

Halsey R. Bazley returned to Pittsburgh as AAA v.-p. in charge of operations.

Donald H. Russell, of Vought, received first Silver Star Medal ever to be awarded a civilian. He was cited for remaining aboard carrier *Franklin* after ship was hit.

Charles J. De Beaver resigned as CAA parachute specialist to join General Textile Mills, makers of non-oscillating 'chutes.

K. J. Kernochan has been named West Coast district mgr. of Goodyear's Aviation Products Div.

J. C. O'Connor returned to Philadelphia as UAL's air cargo area mgr., and **C. J. Middleton** became Seattle district traffic mgr.

Capt. Eddie Rickenbacker's contract with EAL was renewed for 10 yr.

TACA appointments: **Col. William S. McDuffee** has been named a v.-p.; **Col. Leonard M. Rose** was appointed asst. to chairman of board; **Maj. Gerald M. Smith** was named exec. asst.; and **Shelby W. Merrill** became passenger sales mgr.

Dr. William S. Durand received ASME Medal for his work in jet propulsion.

Lt. Stuart T. McAllister has been appointed legal asst. to v.-p. of PCA.

James C. Fuller joined Dallas office of Hill & Knowlton.

Capt. Walter A. Hamilton returned to TWA as special asst. to exec. v.-p.

William E. Cullinan, Jr., has been appointed a member of military affairs committee of National Assn. of State Aviation Officials.

At AA, **Buell Patterson** was named asst. director of public relations; **Allan C. Botsford** became new supervisor of passenger and cargo facilities; and **William C. Bay** returned as director of maintenance and overhaul of company's overseas div. **Col. Jess B. Bennett** joined Braniff as director of research and planning; and **W. R. "Bill" Beattie** was made head of new interline, agency, and foreign sales dept.

C. E. "Jack" Reid has been named mgr. of Air Associates Los Angeles branch.

William Wiseman became asst. chief engineer of Continental Motors' aircraft div.

George D. Brown was named NEA city traffic mgr. for Boston.

Frank W. Jones became head of Northrop's Light Metals Products Div., and **F. J. Baum** has been appointed company's Dayton rep.

At Douglas, **Bruce Del Mar,** mechanical test engineer, received ASME's Junior Award; **Cliff Johnson** joined company's publicity staff; and **Irving Cramer,** news bureau mgr., left to become director of publicity for Los Angeles C. of C.

PAA appointments: **Lt. Comdr. James H. Smith, Jr.,** has been elected asst. v.-p.; and **Robert L. Cummings, Jr.,** became mgr. of Atlantic div.

Kenneth Campbell was awarded SAE's Manly Medal for '44.

Thomas H. Jay became CAL's personnel director.

CAA appointments: **Maj. John F. Warlick** was named regional counsellor, and **Col. Charles E. Cox, Jr.,** and **William M. Berry** became assistants to regional administrators for personal flying development.

Comdr. Thomas M. Jones has been made a v.-p. of Air Power League.

Mrs. Marion P. Davis joined ATA as press liaison specialist.

Col. George H. Moriarty has been appointed chief of RFC's Aircraft Components Disposal Section, Aircraft Div.

PICAO appointments: **Ivor H. McClure** became asst. secy. general for avigation; **Edward A. Westlake** was named chief of air and air traffic control section; and **Col. Reeder G. Nichols** was made chief of communications section.

(*Continued on page* 141)

★ CANADIAN NOTES ★

by James Montagnes

Plan to carry all first-class mail by plane is now before Canadian Parliament.

A. V. Roe Canada, Ltd., purchaser of Victory Aircraft, will operate plant jointly with government, and profits will be shared. Military aircraft and turbojet engines are to be produced, and it's expected that Avro Tudor will also be made. President is Sir Roy Dobson, managing director of Hawker-Siddeley group, while v.-p. and gen. mgr. is Walter N. Deisher, formerly gen. mgr. of Fleet Aircraft, Ltd., Fort Erie.

RCAF is keeping five years' supply of aircraft, is experimenting with jet-propelled craft, and expects it will cost about $80,000,000 annually to keep 20,000 men in its peacetime force. Three bomber, three fighter, three transport, and one photo squadron are to comprise force, with an auxiliary 10,000 men in 19 squadrons and a reserve of 25,000 RCAF vets.

Normal profits, abolition of 8% aircraft sales tax, and easing of customs tariffs were recommended at recent annual meeting of Air Industries & Transport Assn. of Canada. C. H. Dickins, v.-p. and gen. mgr. of Canadian Pacific Air Lines, Montreal, was elected AITA president.

Tailless aircraft investigation is being conducted by National Research Council at Ottawa, including wind tunnel studies and flight trials of a flying model.

★ OBITUARY ★

Dr. Porter Hartwell Adams, prominent in civil aviation. After entering aeronautics with Cooper Aircraft Co., he served in Naval Aviation Corps during Word War I and emerged as Lt. Comdr. He was chairman of executive committee of NAA at its founding in 1922, served as president of organization from 1926 to 1928, and later became member of its senior council. He acted as vice-president of International Air Congress in 1927, was technical advisor to American delegation to International Civil Aeronautics Conference in 1928, and in same year served as chairman of aviation medical section of First National Aeronautical Safety Conference. He became president of Norwich U. in 1933 and served as such for 6 yr., continuing to hold, until his demise, Cabot professorship of air transportation and air traffic. In addition, he was chairman of Vermont State Aero Commission from 1936 to 1940, member of Federal Board of Maps & Surveys, and advisor to Dept. of Commerce and NACA.

Bryce Wilson, PAA official. Entering company's employ in 1928 as mechanic's helper at Miami, he became chief mechanic at Lisbon, Portugal, base in 1939, maintenance inspector at La Guardia Field in 1941, and, finally, asst. maintenance superintendent in 1944.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Strongest plea in current drive for unified command of Army and Navy is the testimony on Pearl Harbor disunity. Single command may be compromised somehow, but AAF expected to win equality. Navy will keep its air arm, which is about as big as its body.

Lighter-than-air and battleships took knockouts in the war. Some people also hold that flying boats lost a decision on points, but the round-by-round poll has yet to be checked.

Motives that pushed wartime aircraft production are missing; the Council is out of business; and the industry is again showing an anemic front in Washington, as in the past, despite earnest efforts of a few members.

Campaign by the surface carriers for the right to fly, and favoring control of all transport by a single commission, is steadily gaining. The aviation industry's weak opposition, also its weak support of the CAB, are all too evident.

Meanwhile, private flying, with more votes than other branches of aviation, is really gaining. It is getting better regulations and airport aid. Continued improvement in organization will bring more benefits. Diligence might even save it from the plight of motorists, who can't find places to park and who face different rules and taxes on every state, county, and city line.

Wilson of AIA Favors Top Policy Group; Specifies Requisites for National Security

. . . Warplane orders too low . . . Cost-plus contracts fade . . . Million workers out . . . Trained engineers needed . . . Radio vs. test dangers . . . Overhaul-lease plan . . . Varied craft mount Majors.

Again, as in the past, there is authoritative demand for an impartial Committee to study existing and probable effects of aviation's phenomenal progress, and to recommend an aeronautical program to the Government.

Eugene E. Wilson, AIA president, has declared that radical new developments, such as the atomic bomb and guided missiles, emphasize the need for prompt appointment of a Presidential Advisory Committee to study implications of the technical advances and to formulate a meaningful national air policy.

The public needs more information, Wilson said, to assay these new developments in terms of air power requirements and organization for national security. In his opinion an impartial study by a committee of distinguished civilians can best provide a basis for a long-term national aviation policy.

He outlined four requisites to national security: (1) Formation of an air policy; (2) establishment of an appropriate organization to execute the policy; (3) continuing congressional appropriations to implement preparedness and research; and (4) legislation providing maximum incentives to private industry to engage in development of defense weapons and instruments.

Warplane Orders Too Low

U. S. aircraft industry, which designed and produced 150 models and 300,000 airplanes during the war, now has on order only about 5,000 military airplanes for Army and Navy through 1948. Scheduled military production for 1946 is less than 2,200 units, which is less than 4% of the July 1945 production rate. Meanwhile the British, who have only one-third the population of the U. S., and who produced only one-third as many warplanes, have effected no extensive demobilization, in fact have placed orders for 10,000 military planes.

Cost-Plus Contracts Fade

Wartime cost-plus-fixed-fee type of aircraft procurement contract is on the way out, except for some types of research and experimental work. The Army will use cost-plus on experimental contracts, but all production contracts will be made by competitive bid or negotiation. Under Navy policy, any exceptions to the lump-sum contract will have to clear through the Secretary. But the Secretary may approve research and experimental contracts on a fixed fee basis if he sees fit.

It is expected that Air Forces will ask Congress for a new procurement law, which would clarify many uncertainties, and which would authorize purchase of enough experimental type planes for tactical testing. Present law is unclear; seems to limit test orders to 1, although 13 has been customary.

Million Workers Out

As a result of U. S. victory in the war, employment in the aircraft industry has declined by more than 1,000,000 to the current total of less than 200,000, according to the AIA. Meantime, Government figures (giving decline to 338,000 by end of September) show that no other industry has experienced half that shrinkage.

But owing to sound contract termination legislation, the industry has weathered the first stage of contraction, and it remains a vital arm of the national defense.

Future of the industry will be determined in large part by its ability to further develop the jet, the rocket, electronics, radar, rotary wing, all-wing, and atomic energy. Of course public recognition and congressional support will be essential.

Trained Engineers Needed

Selective Service draft of young aero engineers is seriously interfering with air research and development and is slowing reconversion, in the opinion of R. E. Gillmor, president of Sperry Gyroscope and a governor of AIA. He cited several difficult situations in aircraft plants due to loss of engineers. Aircraft manufacturers on the Coast and elsewhere are seeking replacements of drafted technicians—even in the want ads—to man their research and civilian plane projects. Douglas Aircraft recently made known it would hire 300 trained men if it could find them.

Radio vs. Test Danger

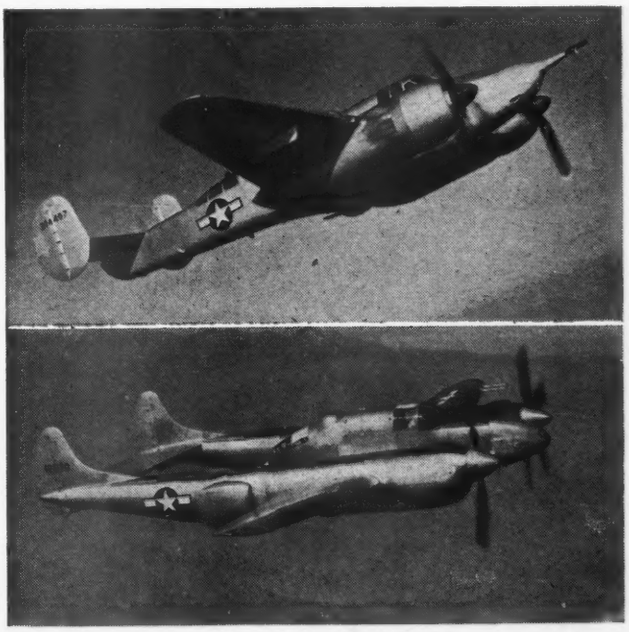
Radio controls already used on guided missiles may be further refined and generally adapted to replace personnel-endangering testing of new-type airplanes, especially in supersonic speeds. Two Bell Airacomet jet planes have recently made such experiments, with one equipped as "mother" plane, the other controlled by it. But in most Airacomet flights, a safety pilot was carried in the controlled plane. It may be possible to stress radio-controlled, pilotless, experimental planes in the air to the point of destruction, at the same time receiving, by radio, automatically transmitted data on all loads and functions of the craft.

Overhaul-Lease Plan

Proposed new Martin service to airlines purchasing Model 202 transports is now being studied by company engineers. Major overhaul work for purchasers would be done at Martin plant, where special maintenance facilities would be installed to eliminate necessity for each airline to have extensive number of planes, parts, supplies, and mechanics for heavy work. Plan would call for the Martin organization to build several craft and maintain them on stand-in status, to be turned over to the airline on lend-lease when another plane is brought in for overhaul, thus avoiding flight cancellations. With nearly all major lines operating through or near Baltimore, location of Martin plant there may make plan workable.

Varied Craft Mount Majors

Pratt & Whitney's new Wasp Major engine is scheduled to power these large four-engine airliners: Douglas C-74 Globemaster, Boeing Model 377 Stratocruiser, commercial Martin Mars, and Republic Rainbow. In addition, it is powering eight-engine Hughes Hercules seaplane, world's largest aircraft, now being assembled. Wasp Major is also to be installed in Army's heaviest bombers—six-engine Convair B-36 and four-engine Boeing B-50 Superfortress. Two of Navy's single-engine fighters—Goodyear F2G Corsair and Boeing F8B—also use power plant. At least six other Army and Navy planes, not yet announced, are also being developed to mount one or more of these engines. The power plant has piston displacement of 4,360 cu. in. and its 28 cylinders are arranged in pattern of four rows of seven cylinders each.



NEW CRAFT FOR AAF CANNONEERS

Readied too late to see combat, Beech XA-38 and Lockheed XP-58 Chain Lightning were designed as powerfully-armed destroyer-types. Top: Dubbed "Grizzly" by Beech workers, XA-38 bears decided resemblance to UC-45, but is powered by two 2,200-hp. Wrights and has a 75-mm. cannon in nose plus four .50s in two remote control turrets. Design gross weight of all-metal craft is given as 29,900 lb. Above: About one-third larger than P-38, two-place Chain Lightning is powered by two 3,000-hp.-plus Allison 3420s and carries four 37-mm. nose cannon and four .50s in two remote control turrets. Interchangeable nose with 75-mm. cannon may also be fitted.

JET PROPULSION TURBINES by BROACHING

Step 2

Broaching by *American* is a fast, accurate, economical method of production. Again and again during the war, industry turned to broaching, the *American* way, to solve metal finishing problems and speed output of the weapons of Victory.

One such problem was the shaping of slots in jet propulsion turbines. For cutting rough slots of proper depth and spacing, an *American* SB-66-15 Vertical Surface Broaching Machine was equipped with a three stage broach assembly.

Each member of the assembly made progressively deeper cuts. The part, with two slots partially cut, was placed in the machine so that the shallow slot came to the center broach and the slightly deeper one came to the right-hand broach. Then the part was automatically indexed with all three broaches cutting shallow, deeper, and full depth slots respectively.

Broaching the *American* way, can help speed output and reduce costs in your plant. Let *American's* complete broaching service — machines, tools, and engineering — work for you. Write today for more information. There is no charge.

WATCH THIS PAPER for another operation in broaching jet propulsion turbines. Step 3—Finishing—will be described in *American's* March advertisement. The first step was described in the November issue.

MEMBER BROACHING TOOL INSTITUTE

American BROACH AND MACHINE CO.

ANN ARBOR, MICHIGAN

•

BROACHING MACHINES
PRESSES
BROACHING TOOLS
SPECIAL MACHINERY

DIVISION OF SUNDSTRAND MACHINE TOOL CO.

★ FOR THE RECORD ★

Fairchild Camera & Instrument Corp. moved general offices and all manufacturing facilities to 88-06 Van Wyck Blvd., Jamaica (1) N. Y.

American Rocket Society has merged with ASME.

TACA appointed Royal & de Guzman as advertising counsel for campaign to cover trade papers, newspapers, magazines, and other media.

Interstate Aircraft & Engineering Corp. purchased Revelation Co. of Los Angeles, maker of water softeners and water coolers.

Air Foundation has been formed as non-profit organization by Cleveland businessmen to promote aviation through public education, research, and aero scholarships. Incorporators include Frederick C. Crawford, A. J. Weatherheed, Jr., A. C. Ernest, and W. T. Holliday.

Waco Aircraft Co. joined AIA's National Aircraft Standards Committee.

National Aero Corp., 709 Market St., Newark, N. J., was formed to establish an aerial taxi service, do aerial advertising, and maintain and repair all types of aircraft.

Bruning Airways, Inc., 31 Elm St., Springfield, Mass., is new company planning to carry mail and express on six routes starting from Springfield and covering 1,737 mi. throughout New England and N. Y.

Engel Aircraft Specialties, Escondido, Calif., again is making manifolds, **NACA-type cowlings,** wheel parts, also **spinners, and** other items **for commercial aircraft. Heavy metals forming is** to be **continued.**

Plastic & Rubber Products, Inc., 3110 Oakridge Drive, Dayton, Ohio, executed license agreement with Nels A. Christensen to make and sell ring seals for hydraulic equipment.

Eaton Mfg. Co., Cleveland, maker of precision parts for aviation and automotives industries, named Florez, Phillips & Clark, Detroit, as advertising agency.

Pacific Automotive Corp. was appointed exclusive jobber for Sherwin Williams aviation finishes in all parts of U. S. west of Mississippi, including Alaska.

Manning, Maxwell & Moore, Inc., Bridgeport, Conn., maker of valves, etc., is building a new plant at Watertown, Mass. for manufacture of Hancock Products.

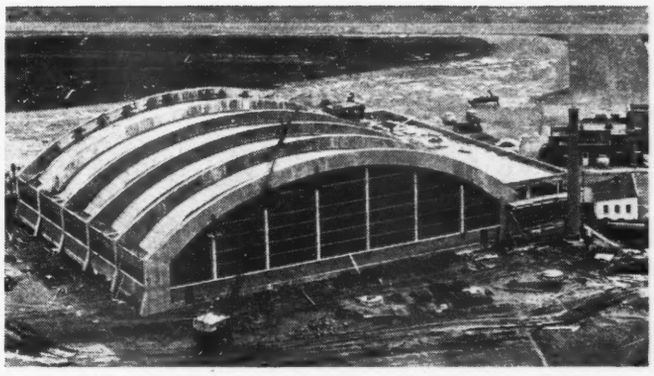
Pittsburgh Plate Glass Co. is constructing new $1,750,000 paint plant at Springdale, Pa.

Harris Pump & Supply Co., Pittsburgh, has been appointed distributor for Gayex Corp., Nutley, N. J., maker of degreasers and cleaners.

Allison Div. of GM opened Washington, D. C., office at 200 Hill Building, 17 & I Streets, N.W., under direction of Guilford C. Pearce.

Westinghouse transferred aviation section activties from industrial sales to marine sales, headed by C. H. Weaver. New setup is known as **Marine & Aviation Sales Dept.**

Air Associates, Inc., Teterboro, N. J., has been named distributor for Airadio, Adel Precision Products, and Aircraft Standard Parts Co.



GE'S ROOST FOR FLYING LABS

Construction by GE of $500,000 hangar for company's flying laboratories is well underway at Schenectady Airport. All-concrete structure will be site of development and test on all types of jet, gas turbine, radar, and electronic equipment. Hangar will be capable of holding four Convair B-24s. One B-24 and a Kellett YG-1A, both loaned by AAF for test purposes, have already arrived, and a Boeing B-29 is among other types expected in near future. Airport lab building is at far right.

Trans-Caribbean Airlines appointed Norman A. Mack & Co. as advertising counsel for air cargo and passenger divisions.

C-W acquired Marquette Metal Products Co. of Cleveland, maker of precision parts for aviation and automotive industries. . . . Wright Aero leased government-owned plant at Woodridge, N. J.

B. F. Goodrich acquired Hycar Chemical Co., maker of Nitril oil-resistant synthetic rubber. Physical assets and trade names were included in transfer and all Hycar products will be marketed by new owner.

Douglas granted Aero Components, Inc., exclusive license to make and sell spare parts for C-33 (DC-2), C-39 (DC-2½), B-23, A-24 (SBD), and A-20. Component company is located at 5651 West Century Blvd., Los Angeles Municipal Airport, Los Angeles (45), and Vic Pastushin is president.

Hydro-Power, Inc., maker of hydraulic valves, etc., are building new plant at corner of Sheridan and Belmont Streets, Springfield, Ohio.

★ KNOW-HOWS ★

Gasoline-cooling for submerged fuel pump motor has enabled Westinghouse to produce 2¼ hp. unit, weight under 20 lb.

Use of dropped weight to add impact to hydraulic pressure is reported by Colonial Broach Co. to have eliminated creeping of cylinder liners after cooling.

Internal nickel plating of steel tubing by method devised by Bart Mfg. Co. is stated to give tubing the corrosion-resistance of nickel, even after welding or cold reduction of diameter.

Monel wire mesh radar reflectors, employed by aircraft crews adrift in rubber life boats, are stated by ATSC to have greatly aided rescue work.

Quick-fit-parachute harness, devised by Pioneer Parachute Co., is stated to have reduced adjustment time to 8 sec.

Soap films lasting through working day are being used in beam testing, says Glycerine Producers' Assn. Mixture consists of small quantity of triethylamine oleate in 50% solution of glycerine in water.

★ INDUSTRY MEMOS ★

Ryan entered into agreement with RFC whereby company will act as agent to sell Ryan-built spare parts for surplus ST-3KR (PT-22). Company states that parts catalogs, pilot's handbooks, service instructions, and repair handbooks are also available on this plane, as are spare parts stocks for all other Ryan commercial craft.

Solar received orders from Clinton Engineering Works for atomic bomb stainless steel parts . . . Solar has new triple unit exhaust system for personal planes which can be used for carburetor de-icing, and cabin or windshield heat . . . Company's total unfilled orders are $6,402,811.

Fairchild set up personal planes div., allowing Hagerstown plant to concentrate on military, naval and commercial craft . . . Company is testing new M-84 four-place low-wing cabin plane, powered by 220-hp. Continental, with a sea level top speed of 150 mph. New craft utilizes many PT-23 parts and has retractable landing gear.

Westinghouse revealed details of two new jet engines developed for U. S. Navy. First model is Yankee, only 19 in. dia. and weighing less than ½ lb./lb. thrust (see feature article, page 60). Energy is stated to be equal to 1,400 hp. at 375 mph. Also disclosed was Baby Jet measuring only 9½ in. dia. and giving 275 lb. thrust. Latter is for powering Navy pilotless missiles.

Bendix company's first civilian models of Stromberg direct fuel injection system for Wright Cyclone engines are being supplied for use on TWA's Lockheed Constellations.

Spartan Aircraft has added aluminum trailers to products.

Martin received orders from EAL for 50 Model 202 airliners, costing over $10,000,000, with first delivery scheduled for April, '47. Colonial Airlines also ordered 20 of craft at about $4,000,000 . . . Company flight-tested amphibian version of Mariner, designated XPBM-5A. Landing gear is a special Martin design, with single steel shaft hydraulically operated and fitted with automatic locks. It's stated that only 4,500 lb. have been added to craft's weight.

Boeing signed contracts with PAA for delivery of 20 Stratocruisers to cost more than $25,000,000. Deliveries are scheduled to begin in Nov. '46. Negotiations are also under way, it's said, with AA, NWA, TWA, and foreign agencies. Fitted with P&W Wasp Majors, craft will require less than 6,000 ft. of runway for operations, according to Boeing engineers. It will have half of lower deck devoted to express cargo, and tentatively will have 35 berths for night flights. Wing loading is said to approach 71 lb./sq. ft.

Beech is at work on a new four-place all-metal craft designed for medium price range.

Luscombe's Garland plant, near Dallas, is currently turning out three Silvaires per day.

★ CALLING NAMES. ★

(*Continued from page* 138)

R. A. Bailey has been appointed chief engineer for Laister-Kauffmann:

Wesley B. Warren was named employment mgr. for Delta Air Lines.

EAL appointments: **John Lyons** has been made New England district traffic mgr.; **Charles A. Tehan** was named traffic mgr. of Detroit-Miami run; **Donald Ewald** became Cleveland mgr.; and **John Walker** was named Cleveland reservations mgr.

John Snure, Jr., was appointed Bell director of public relations.

George E. Bounds, C&S public relations director, has been awarded Burton-Bigelow Trophy, top prize for industrial editors, by Southwestern Assn. of Industrial Editors.

Lt. Comdr. H. Gilbert Smith has been elected v.-p. in charge of traffic for Expreso Aereo Interamericano, S. A., Cuban airline. **W. L. Wilkinson** has been appointed sales mgr. for Solar Aircraft.

Robin A. Bell has been appointed sales mgr. of newly-established Janitrol Heater Div.

Mrs. Alice Rogers Hager, Washington aviation editor and author, received Avon Award for Women of Achievement at recent AWA dinner.

James W. Eben has been named director of advertising and public relations for United Aircraft Products.

Francis A. Callery resigned as Convair financial v.-p., but he will continue connections with company in advisory capacity and will remain a director and member of exec. committee.

AIA appointments: **Lamotte T. Cohu** of Northrop was elected pres., succeeding **Eugene E. Wilson,** who was named chairman of board. **Robert E. Gross** and **Lawrence D. Bell** became v.-p.'s and **Harrison Brand,** secy.-treas. **E. R. Breech, Alfred Marchev, William A. Allen,** and **Donald W. Douglas** were named to exec. committee. **W. T. Piper** was elected to board of governors. Joint Technical Board has been established composed of **Wellwood Beall, Wright Parkins, Erle Martin,** and **R. P. Lansing.**

Britain Permits PAA, AOA 14 Trips and 500 Passengers Weekly; Minimum Fare Is $375

. . . Prices go down on C-54s . . . Detail new CAR revisions . . . Direction-finding stations to facilitate traffic . . . Hit British "nationalizers" . . . Favor for world authority; Sanctions asked in House.

Trans-Atlantic passenger-fare storm developed when PAA, at conclusion of 30-day waiting period required by CAB, opened up with its new $275 New York-London ticket, a fare which cut in half the competitive charges. Rate-structure confusion was the result.

Initial speculation was that CAB might step in with adjustments "to prevent destructive competition," and some people talked of possibilities, accordingly, of eventual subsidies.

To brief the story, PAA and AOA had scheduled several new Atlantic trips per week, a step-up from the two round trips weekly which had been run in accordance with the U. S.-Britain 1937 agreement, which had been observed up until the war and continued thereafter on a temporary basis. British sources have said that a further bilateral understanding was called for prior to any increase in trips; however it appears that neither side brought up this point when, at the close of the war, PAA and AOA were permitted test runs, following them with five and three schedules, respectively.

However, with the announcement of the $275 PAA fare, things began to happen. Britain called for a schedule-cut—back to the two-a-week basis—and an impasse loomed. But then a fare of $375 (understood to have been recommended earlier by the IATA) was determined; and Britain, announcing this charge to be acceptable, then stated that on a temporary basis, 14 trips per week, divided between PAA and AOA, would be permitted, with a further proviso that no more than 500 passengers were to be carried in any week.

From London there now comes a report that Britain's Ministry of Civil Aviation will accept any such fare basis as may be determined by the competing airlines in conference. It is to be noted that the original 1937 agreement did not consider fares.

Prices Go Down on C-54s

Reductions of 25% to 40% in the prices of Douglas C-54 airplanes, estimated to enable the airlines to purchase 103 more units than under old prices, have been announced by the Surplus Property Administration, following a bargaining session with the Air Transport Assn.

A C-54B is now $90,000, as compared with the old price of $150,000 which took into account 50% allowance for conversion costs. The new prices do not provide for conversion costs. C-54As are priced at $75,000 and C-54Es at $100,000.

Disposal agencies are authorized to increase or decrease prices by not more than $10,000, depending on condition of the unit. Leasing terms remain the same, except for a slight reduction for equipment to be used in cargo operations. More than 150 C-54s have been leased to U. S. and foreign operators.

Detail New CAR Revision

In further revision of CAR Parts 04, 41, and 61, CAB announces its decision to require: (1) That the steady rate of climb at 5,000 ft. with all engines at maximum continuous power, and with the plane in a cruising configuration, shall not be less per minute than 8 V_{s_0}. Operating rules will prescribe a rate of climb of 6 V_{s_0} at 1,000 ft. over highest terrain on route; (2) that 4-engined planes will not be dispatched on routes where more than 90 min. are required to reach a landing field, at a weight greater than would permit a climb rate of .01 $V^2_{s_0}$ with two engines out and the other two at maximum continuous power at 1,000 ft. above highest terrain on route or 5,000 ft., whichever is higher. Method of compliance is shown in CAB release.

Direction-Finding Stations To Facilitate Traffic

CAA has ordered the installation of 20 direction-finding stations at twelve major airports, to cut landing time to two or three minutes and facilitate traffic movement during winter weather, pending switch to VHF instrument procedures, now in process of installation. The airline fleet will be completely equipped with airborne instrumentation by next September. CAA estimates that by 1950 the present 300 airmail-passenger stops will have doubled to 600 and that about 180 of these will have ground facilities in service.

All airplanes are equipped to co-operate with fan markers. Nearly all have localizer receivers. Only a few glide path receivers are in use; procurement will begin this month. All equipment presently is Army surplus, which requires modification. The airlines have 500 communications circuit receivers going through modification. Twelve CAA ground stations are in service; 10 are in process of construction; 40 are planned in 1946; funds are requested for 30 in 1947. Twenty-seven stations have been completed for the Army, plus 5 in process; and 2 have been completed for the Navy. How many instrument-equipped military fields will become available to civilian flying is not known as yet.

Hit British "Nationalizers"

With three U. S. flag trans-Atlantic air routes now in operation, further rate reductions in prospect, and schedules running about ten to one for the British, the English press, as summarized by the Society of British Aircraft Constructors, has strongly attacked the Atlee labor government for its proposals to nationalize the Empire's airlines (also see feature article, page 40). "It is a rash adventure," said *The Daily Mail*, "and it will be instructive to see how it fares against the brilliantly organized, privately controlled airlines of the United States."

The British haven't got far, as yet, in producing airplanes for profitable Atlantic crossings, because they concentrated on bombers during the war.

Favor for World Authority; Sanctions Asked in House

Economic regulation of airlines by international authority, rejected by the U. S. at the Chicago civil aviation conference, appears to be gaining favor. Dr. Edward P. Warner, president of the Interim Council of the Provisional International Civil Aviation Organization, recently stated that if there are to be rules governing competition among world airlines, such rules will have to be administered by international authority. The U. S. favored only technological regulation, while the British wanted economic control. Dr. Warner said, "The case for making one world in the air is an almost self evident one."

Use of economic sanctions against countries which do not grant free operating rights to U. S. airlines is recommended

MAINTENANCE TOPNOTCHERS FOR '45

Smiles token pleasure of Eastern Air Lines' and Delta Air Lines' officials as they receive AVIATION-AIR TRANSPORT 1945 Maintenance Awards. At left, AVIATION Editor Leslie E. Neville presents to EAL executives plaque honoring airline in over-10,000,000-mi. category. Seen (l. to r.) are: EAL Asst. Op. Mgr. J. H. Halliburton, V.-P. in Charge of Op. S. L. Shannon, Mr. Neville, Supt. of Maint. H. G. Lesley, Supt. of Overhaul J. C. Ray, and Supt. of Communications D. C. McRae. At right, plaque awarded in less-than-10,000,000-mi. class is received by Delta Op. Mgr. George R. Cushing (left) and V.-P. & Gen. Mgr. C. E. Woolman. Dual ceremonies in Miami and Atlanta featured 9th presentation of coveted honors.

THE end of the wartime aircraft program immediately eased the heavy pressure on Revere's aluminum alloy tube mills. With backlogs quickly taken care of and production completely in step with day-to-day demand, Revere is now better able than ever before to give you quick service, immediate delivery information, and extremely prompt shipments of tube.

Alloys 2S, 3S and 52S are available in all tempers from soft to hard. Alloy 24S is available in the annealed condition "O", or the heat-treated condition "T". For the production of square and rectangular tubing only a few additional days are required. Revere's fabrication and inspection facilities are complete, so that all established specifications can be fully met without delay.

Revere's fine aluminum alloy tube is well known to the aircraft, automotive, electronics, chemical and other industries, in which it met the most critical standards imposed by the needs of war. For your present or projected projects Revere will continue to produce tube of this same superior quality. A Revere Technical Advisor will gladly consult with you about Revere copper, brass, bronze, aluminum, magnesium, steel. Full information is available at all Revere offices. Write, wire or phone Revere today.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Ave., New York 17, N. Y.

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in principal cities.

Listen to Exploring the Unknown *on the Mutual Network every Sunday evening, 9 to 9:30 p.m., EST.*

Pioneer presents- The New QUICK-FIT Parachute Harness*

Complete, Easy, Automatic Adjustment in 3 SECONDS
Follow the photographs clockwise. Note how quickly and easily the same Pioneer Harness achieves a perfect fit for the 6'-2" two hundred forty pounder as well as it does for the 5'-2" one hundred two pound lightweight. Both are perfectly fitted with the same harness in less than three seconds. No separate adjustments between sizes are necessary, thus outdating the harness that has to be adjusted to fit each person.

** Patents applied for in U. S. and all principal countries throughout the world.*

Note How Easily Harness is Adjusted:

Snap chest strap in usual way . . . Snap leg straps in usual way . . . Then, in less than 3 seconds, a simple tug at leg straps and chest straps automatically draws harness into perfect fit.

TO REMOVE HARNESS; a simple tug at chest strap fitting and leg strap fitting automatically loosens the harness — then just detach in the usual way.

The harness may, if desired, be loosened while in flight and instantly tightened in case of emergency; thus giving the wearer extreme comfort (as if no harness were worn at all). This is not possible with any other type of harness.

CHENEY

PIONEER PARACHUTE COMPANY, INC.

MANCHESTER, CONNECTICUT, U. S. A.

CABLE ADDRESS PIPAR. TELEPHONE, Manchester 4157

WEST COAST FACTORY BRANCH, 109 SOUTH CENTRAL AVENUE, GLENDALE 4, CALIFORNIA

by the House Postwar Economic Policy Committee. The Committee suggests that surplus planes and loans be withheld from countries that do not cooperate, specifically naming Russia and Great Britain. Russia is charged with lack of interest in exchange of civil aviation rights, and the British with obstructing U. S. air operations in Europe.

World Body Gathers Data

The PICAO Air Transport Committee is sending out questionnaires asking for a variety of technical and economic information from the governments of all member states. The forms have been adopted, and PICAO was hoping that the data would be in by first of the year so that a first annual report could be made shortly thereafter.

★ CROSS COUNTRY ★

Under recently awarded $12,500,000 bond fund, contracts have been awarded for construction of four new buildings at Los Angeles Municipal Airport. TWA, UAL, and WAL will lease three of structures, while fourth is to house offices, weather bureau, post office, and CAA. New grading, parking areas, utilities, taxiways, and aprons are being completed, costing $750,000. When improvements are finished, in expected three to five years, airport will represent $25,000,000 investment, with one runway extended to 10,000 ft., another to 7,500 ft., and two more 7,000 ft. runways.

TWA: Airline's new Lockheed Constellation, Paris Sky Chief, flew from Washington to Paris in 14 hr. 48 min. including stops. Flight time was 12 hr. 58 min.

Braniff started airfreight service in 32 cities, with rates of 35–45¢ per lb., with 25-lb. minimum.

PAA: Douglas DC-4 Clipper was sent on 20,000-mi. survey flight from N. Y. C. to Calcutta, carrying 24 technical experts to determine available facilities en route. . . . Unrestricted commercial flights to Hawaii were resumed. . . . New Latin American services consist of 22 daily Clipper flights between Havana and Miami; 4 daily flights between Barranquilla, Colombia, and Miami; 4 daily flights between Nassau, Bahamas, and Miami; twice daily flights between Port of Spain and Miami; and new daily round-trip Clipper cargo flights between San Juan and Miami. . . . Airline concluded ticket agreement with Irish Aer Lingus Teoranta whereby any of PAA's ticket agents anywhere can sell tickets on Irish airline. . . . Reductions of 1-10% were made in passenger fares to and through South America.

UAL: Engineers are studying five designs of new high-speed twin-engine airliners as replacements for Douglas DC-3s. . . . Refrigerated Cargoliner carried full load of flowers, fruits, vegetables, and serum from Los Angeles to N. Y. C., and, after unloading, picked up over 2½ tons of fillet of haddock for delivery to Chicago and San Diego. . . . Airline began passenger service in Detroit, operating to Chicago and points west, and east to Washington, Phila., and N. Y. C.

National Skyway Freight (Flying Tigers) flew first shipment of postwar cleaners and irons produced by Eureka Vacuum Cleaner Co. from Detroit to N. Y. C.

AOA: First direct airline service from Chicago to London was flown, as was first flight from Phila. Southwest Airport to London. . . . Mexico extended AOA the privilege of issuing Mexican tourist cards direct to passengers on pleasure trips in the country.

WAL: Once-daily air service was started to Palm Springs, Calif. . . . Company inaugurated direct service between Denver and Los Angeles. . . . Airline plans to spend more than $15,000,000 for additional planes, facilities, and ground equipment. Included will be a fleet of 28 Douglas DC-4s and DC-6s.

Expreso Aereo Interamericano, S. A., Cuban airline, purchased land for an airport at Santiago de Cuba and plans to extend service to there when facilities are completed.

TACA began daily service to Havana, British Honduras, and Central America, with service between Mexico and Central America increased to a daily basis.

PCA revised flight schedules with daily express flights between Baltimore and Cleveland; Detroit, Chicago, Milwaukee and N. Y. C.; Chicago and Baltimore; N. Y. C. and Knoxville; N. Y. C. and Birmingham; Pittsburgh and Birmingham; Pittsburgh and Milwaukee; and Buffalo and Washington. . . . New and faster round trip service was opened between Milwaukee and Detroit, Youngstown and Washington, Cleveland and Baltimore, Washington and Buffalo, and Baltimore and Detroit. . . . Also there was addition of new nonstop Baltimore-Cleveland flight, added Washington-Cleveland service, a new Norfolk-Chicago flight, and faster schedules between Cleveland and N. Y. C., Chicago and Detroit, and also between Milwaukee and Detroit.

Westchester Airport, Inc., N. Y., has acquired ownership of airport at Armonk, N. Y., and plans to enlarge latter's facilities.

New runway lighting system to provide an "aisle of light" is planned for Idlewild Airport, N. Y. C. Developed by Westinghouse, method will consist of parallel walls of light projected from prismatic lenses installed every 200 ft. along runways. It is stated that new guide will not interfere with pilots' vision. System will use approximately 30,000 watts.

New Orleans dedicated Moisant International Airport comprising 1,360 acres, with three 5,000 ft. and one 7,000 ft. runways. Equipment includes VHF instruments, also neon approach-lane contact lights.

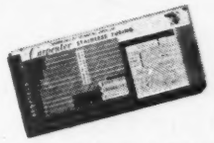
Air Express Div. of REA inaugurated rate reductions of up to 13% on air express.

A new approach to airport planning is presented in "Looking Ahead to the Airport Center of Tomorrow," a study made by The Ric-Wil Co., Cleveland, maker of insulated pipe conduit systems. Well-illustrated, booklet contains diagrams, specifications and cost figures on centrally heated airfields, laid out with self-contained community housing and industrial projects. It will be mailed on request.

Air Cargo Transport flew 4,000 lb. of frogs legs from Miami to N. Y. C. in 8 hr., culminating experiments by National Frosted Foods, Inc. Plane was precooled on ground, then flown at altitudes which maintained freezing temperatures.

1" I.D. Stainless Steel Hose, closed pitch, made from Type 304 Carpenter Stainless Tubing 1½" O.D. x .025" wall. Used for fluid and steam lines, flexible connections between rigidly held units, to reduce vibration.
Why the Fabricator Made it from Carpenter STAINLESS TUBING

● This flexible stainless steel hose is one of many specialty items made by fabricators of Carpenter Stainless Tubing. When *you* need specialty Stainless Tubing to meet your design-engineering requirements, make use of our experience. We can provide the correct type of close tolerance 100% hydrostatically tested tubing. And we will be glad to put you in touch with specialty fabricators.

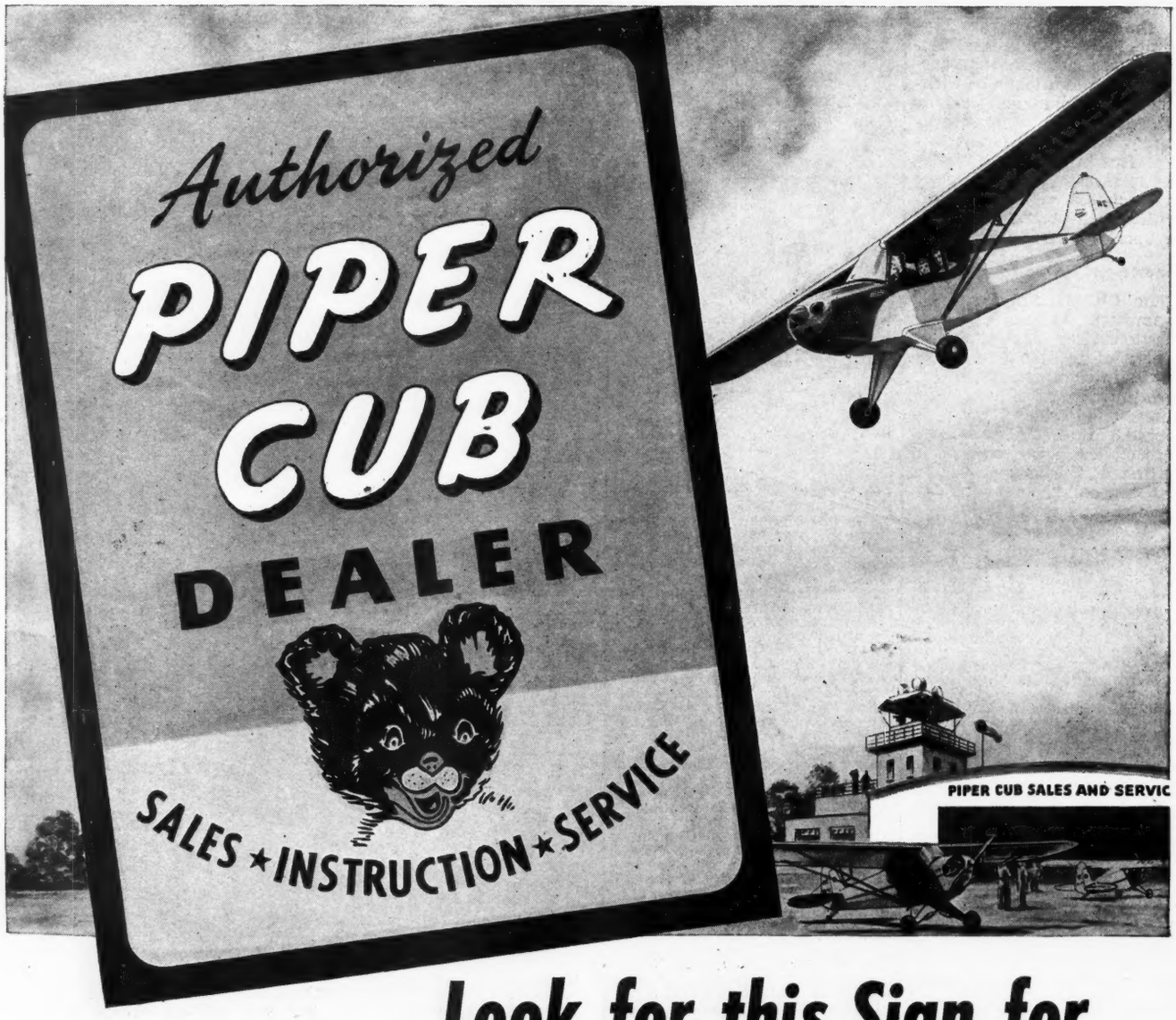


ASK FOR THIS NEW SLIDE CHART OF TECHNICAL DATA

In convenient form, this slide chart gives you useful information on: • Mass Velocity Constants (V_m) • Velocity Constants (V_1) • Cross Sectional Areas of Tubes • Sq. Ft. Internal Surface per Lineal Foot of Tube • Physical Properties of Stainless Tubing. A note on your company letterhead will start your Stainless Tubing Slide Chart on its way. Write for your copy today.

Welded Alloy Tube Division
THE CARPENTER STEEL COMPANY
Kenilworth, New Jersey

Carpenter
WELDED
STAINLESS TUBING



Look for this Sign for
GOOD, SAFE PLANES

This sign represents a reputation in aviation. It identifies a dependable dealer backed by a name that has meant leadership in the light plane field for over fifteen years.

Today, more than ever, you can depend on your Piper Cub Dealer for good, safe planes you can afford to buy and fly . . . planes with a time-honored reputation for quality and dependability.

When you want the most for your money in an airplane, in flying instruction and in service . . . look for the sign that says "Authorized Piper Cub Dealer."

"HOW TO FLY" BOOKLET FOR YOU. Covers basic steps in flying with 53 photos and descriptions. Many other facts and full-color pictures of Piper Cubs. Ask your Piper Cub Dealer for your copy or write Dept. A16, enclosing 10c in stamps or coin for postage-handling.

IS YOUR TOWN READY TO FLY? Free booklet, "What Your Town Needs for the Coming Air Age" will help your town plan an inexpensive landing area now! For your copy, write Dept. A16W.

GREAT OPPORTUNITY FOR SERVICEMEN—Do you want to get into aviation when discharged? Let us tell you how you can capitalize on your experience. Write full information regarding yourself to Dept. A16S.

PIPER AIRCRAFT CORPORATION ★ LOCK HAVEN, PENNSYLVANIA

In Canada—Cub Aircraft Ltd., Hamilton

★ INTERNATIONAL BRIEFS ★

ENGLAND—BOAC and South African Airways have opened regular service between Hurn and Johannesburg, using Avro Yorks. First trip was made in 68¼ hr.

An Avro Lancastrian of BOAC recently completed a three weeks' survey trip of proposed route between Great Britain and South America.

Minister of Supply & Aircraft Production recently stated that British aircraft industry now employed some 900,000 people, and that more than 10,000 new military planes were currently on order.

Prototype of the Bristol firm's Freighter was about to fly this month, while four more models are in advanced stages of construction.

IRELAND—Eire is spending more than $4,000,000 on development of a trans-Atlantic airport at Rinnena. Said to feature miles of clear approaches, field's runways are being lengthened to 9,000 ft. At same time, Collinstown Airport at Dublin is also being enlarged. Its present turf surface will readily accommodate Douglas DC-4s.

Aer Lingus Teoranta, official Eire airline, is now operating between Dublin and Liverpool. Plans call for reopening routes to London and Isle of Man, with special emphasis on Rinnena-London feeder services.

BELGIUM—Sabena is now operating regular commercial services from Brussels to London and Paris.

FRANCE—Air France, official French airline, is operating to both London and Amsterdam, with services to other European capitals expected shortly. International operations with six-engined Latecoere boats have so far been held up by minor mishaps.

SWEDEN—Among new planes now being tested here are: SAAB 90, a 24-passenger twin-engined plane in DC-3 class; SAAB 19 and 23, single-engined fighters with Bristol and DB engines, respectively; and SAAB 24, a twin DB-engined light bomber.

Expansion plans of ABA and SILA, which are expected to merge as defense against government influence, are being held back by a shortage of crews. Personnel from all over Europe is now being used, pending training of Swedes.

NORWAY—A new Norwegian airline with a capital of about $4,000,000 has been formed, steamship interests running to about 75%. This company is to take over after Royal Norwegian Air Transport drops its services in March or April. Equipment will be Douglas DC-3s, Lockheeds, and Junkers 52 seaplanes.

DENMARK—Failure of British manufacturers to meet promised delivery dates has forced DNL to use FW Condor's again. Line lost interest in American planes when it figured on getting virtually immediate delivery of English planes at attractive terms.

n making between Danish, Norwegian, and Swedish, and possibly Finnish airline operators, is agreement for joint operation of a Scandinavian trans-Atlantic line.

NETHERLANDS—Albert Plesman, KLM managing director, recently stated that rehabilitation of KLM would require up to 50,000,000 guilders ($27,000,000 at prewar exchange).

ETHIOPIA—Government here has requested Swedish ABA to assist in establishing an airline in Africa.

ARGENTINA—First of four Sunderlands purchased by Senor Dodero, shipping magnate, for his proposed South American services, recently arrived in Buenos Aires.

AUSTRALIA—RAAF Transport Command has started a weekly service to Tokyo. After arrival of Australian troops in Japan, frequency is expected to be increased.

At press time, word came that first steps were taken by Australian National Airways against airline nationalization bill (see feature article, page 40) when an injunction was filed to restrain Government from interfering with line's operations.

MEXICO—Aero Transportes S.A. recently went through reorganization and again plans operations after having suspended services for several months.

Avowed intention of Mexican Government to bring down all airfares by approximately 20% has airline economists checking possible effects on their revenue and profit performance.

WORLDATA . . . . . By "VISTA"

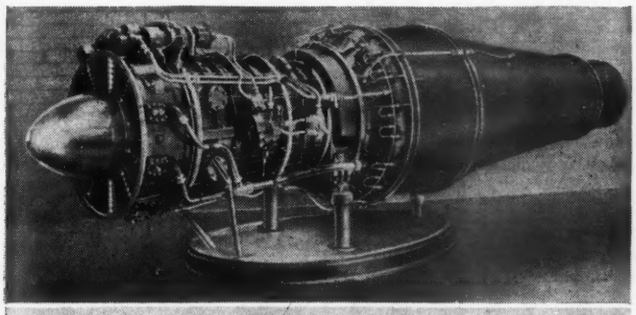
In Mexico, the friction between Pan American and Aerovias Braniff continues, and some people see signs of it getting worse. While AB's Mexico City-Laredo business is satisfactory, the company has been beset with difficulties in its attempts to use Nuevo Laredo Airport—owned by PAA. Accordingly, Braniff has applied to CAB for permission to employ the Laredo, Tex., field until further notice. Moreover, there is additional difficulty for AB on the Mexico City-Merida run: PAA, holding AB's operations at Merida to be an encroachment, is reported to have blocked AB's move to use the servicing facilities, so AB must carry enough fuel between Vera Cruz and Merida to cover the return flight, a condition holding down the DC-3 passenger loads and therefore the profits. Indications are that Braniff, while battling it out on these two prime routes, will hold back on the other routes it had planned. This policy appears supported by fact that Braniff recently released some 150 of its Mexican personnel.

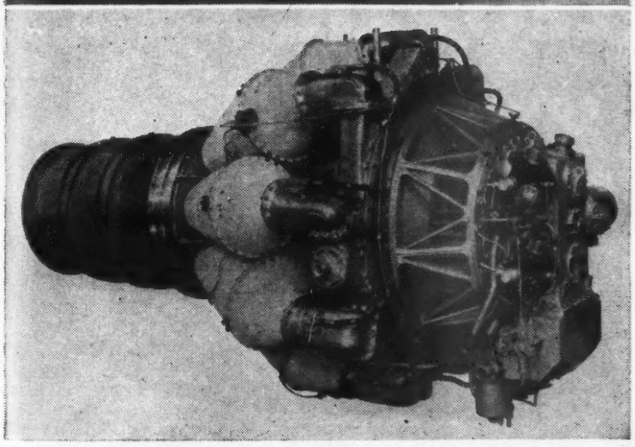
Aerovias Azteca, which had broad plans not only for Mexican services but also for operation to Paris, Tokyo, and Buenos Aires, was reported liquidating its stock of gasoline and supplies. It was said in Mexico City that the company had bought planes, land, and equipment and had hired initial American personnel. It appears, however, that the promoters could not "sell" Azteca, and hence it did not blossom.

Move of Britain to hold PAA down to two runs to England per week (see story in Transport news section) recalled how Swedish ABA was forced to cut three schedules from its six-a-week air service to London (Worldata, Dec. AVIATION). Latter cut, however, was said to have been based on Britain's "equal frequency" policy.

Enigma, meanwhile, is refusal of the British to let U. S. airlines use the airfield at Bovington, only 25 mi. from London's center—instead of the one at Hurn, which is an inconvenient 125 mi. away.

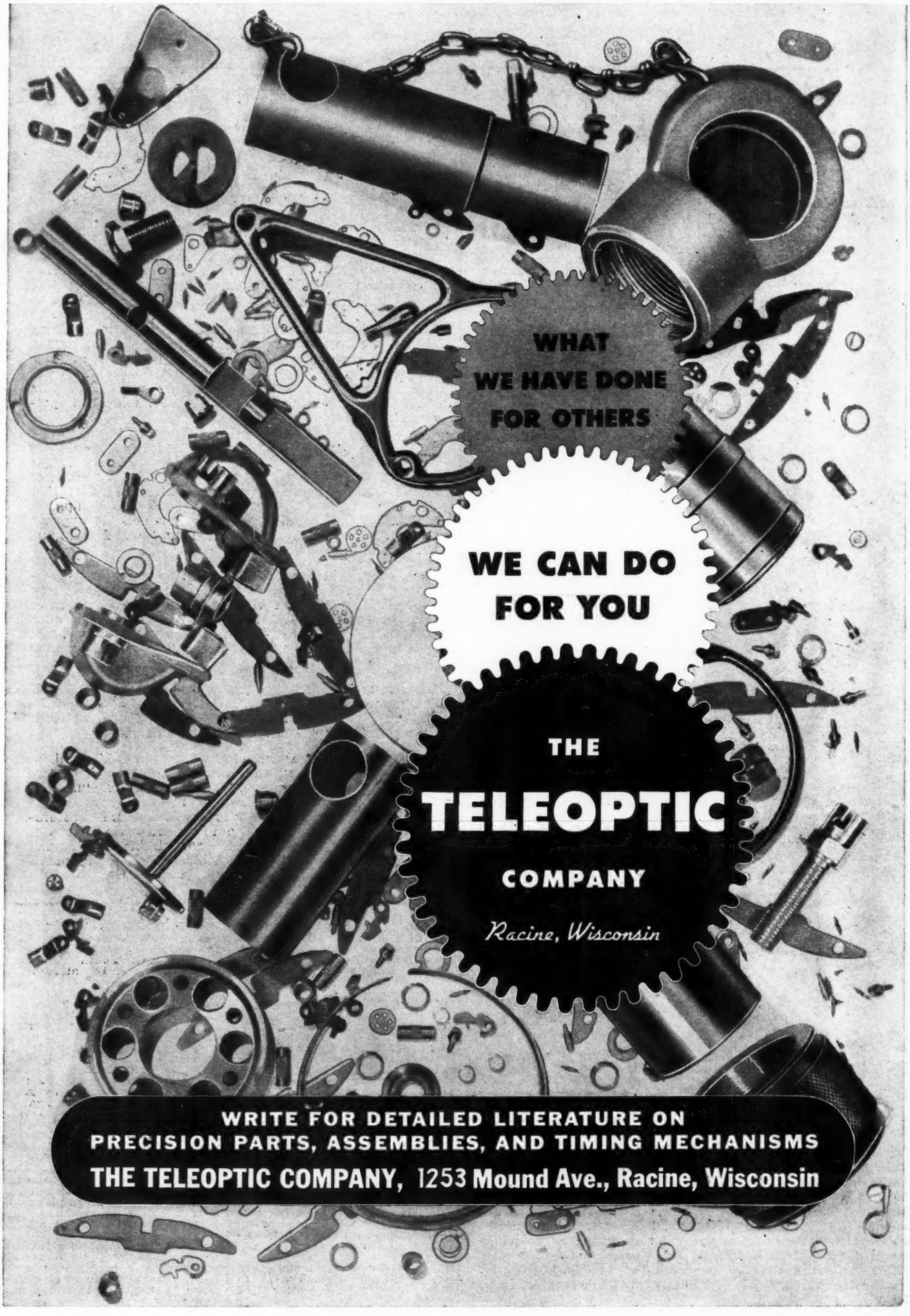
U.S.S.R.'s air network covered more than 86,000 mi. at latest check, with all the Russian capitals except two linked with service under 24 hr. Regular schedules are also maintained to health resorts, to Siberia, and to the Caucasus. Connections are also available with most European capitals, and a service to America via Alaska is expected this year. It's said Moscow airport now handles some 1,000 passengers per day, in addition to shipments running as high as 30 tons per day.





BRITISH JET-MAKERS' LATEST ENTRIES

Two new British approaches to jet propulsion power plant design are shown in axial-flow and centrifugal engines. Top: Metropolitan-Vickers Electrical Co. developed this F2/4 axial-flow type, stated to give 3,500 lb.-thrust at 7,700 rpm., with fuel consumption of 1.05 lb./lb.-thrust/hr. Overall length is given as 13 ft. 3 in., maximum dia. as 3 ft. 3/4 in., and weight as 1,750 lb. Above: Rolls-Royce Nene has double-entry centrifugal compressor, single-stage turbine, and nine straight-flow combustion chambers. Static thrust is 4,000 lb. and maximum thrust 4,500 lb. at 12,300 rpm. at specific fuel consumption of 1.06 lb./lb.-thrust/hr. Maximum dia. is 3 ft. 6½ in., overall length 8 ft. 1 in., and net weight 1,000 lb.


WHAT
WE HAVE DONE
FOR OTHERS
WE CAN DO
FOR YOU
THE
TELEOPTIC
COMPANY
Racine, Wisconsin
WRITE FOR DETAILED LITERATURE ON
PRECISION PARTS, ASSEMBLIES, AND TIMING MECHANISMS
THE TELEOPTIC COMPANY, 1253 Mound Ave., Racine, Wisconsin

Convair has retired $20,000,000 of promissory notes. Company also has granted options to 32 executives to buy 93,450 shares of common at $25 a share.

National Aviation Corp. has elected to become a "regulated investment company" under provisions of Internal Revenue Code. Such companies are not required to pay appreciation taxes on capital gains dividends.

Northwest Airlines stockholders have authorized an increase in capital stock from 600,000 to 1,000,000 shares to provide for expanded capital requirements.

Dividends: Martin paid a $1.50 common dividend on Dec. 21. . . . National Aviation paid $2 a share on same date, bringing 1945 disbursements to $2.25 a share against 75¢ in 1944. . . . Curtiss-Wright declared a 50¢ year-end common dividend. . . . Other December payments were Cessna, 25¢ against 40¢ in 1944; Fairchild Engine & Airplane, 20¢; Continental Motors, 20¢; Bendix Aviation, 0¢ against 75¢ in previous quarters; Continental Aviation & Engineering, 5¢; and Air Associates, 20¢ on common.

Earnings of airlines this year will be "substantially lower" than in 1945, according to Pres. Patterson of UAL. Despite a big increase in air travel, personnel training, conversion of war transports, and higher wages were listed as offsetting elements. He predicted that passenger load factor might decline to 70% of plane capacity next fall against current figure of around 90%.

Aviation Corp. publicly offered 67,374 shares of preferred stock at $56 a share through a banking group. Stock represented balance of 289,675 shares first offered common stockholders but which was not taken up by them.

Square D Co. has retired all of its 5% preferred stock at $105 plus accumulated dividends. Stock was convertible into common at 2½ shares of common for each preferred share.

WAL is obtaining about $4,000,000 in new capital by selling 108,489 shares to stockholders at $20 a share and offering an additional 25,436 shares to employees. Company plans to spend more than $15,000,000 for additional Douglas transports, facilities, and various items of ground equipment.

Republic Aviation Corp. has purchased Aircooled Motors Corp. of Syracuse, N. Y., for $1,500,000. Republic Pres. Marchev will become board chairman of Aircooled company, which has more than $2,000,000 in unfilled orders for its Franklin aircraft engine.

American Airlines reports net profits of $4,059,843 or $3.15 a share for nine months ended Sept. 30, against net profits of $3,991,688 or $3.09 a share in like 1944 period. Operating revenues were $35,303,162 in nine months, against $27,900,763 in same 1944 months. AA does not expect to be subject to excess profits taxes for 1945.

TWA reports net profits for nine months ended Sept. 30, 1945 of $1,660,072 or $1.69 a share, against net profits of $2,036,973 or $2.09 a share in like 1944 period. Operating revenues were $25,467,776 against $18,274,043.

NA reports a net loss of $19,529 for four months ended Oct. 31, against a net loss of $13,891 in like 1944 period. Four months gross was $1,343,426 against $786,209.

UAL convertible preferred recently sold above 180 against a 1945 low of 118. Conversions into common (at $30 a share) have been going on at rate of about 1,000 shares a week. If company decided to call in preferred it could force conversion of entire issue into common stock.

Boeing Aircraft is understood to be "in the black" for second half of 1945, despite reconversion problems. While Boeing did not take action last fall on dividend usually declared at that time, it is expected that dividend policy will be reappraised in 1946 due to large transport orders now at hand or under negotiation.

Mid-Continental Airlines reports September operating revenues were higher than in like 1944 month. Net profits for September were $28,589, against $35,792 in preceding month and $23,958 in like 1944 month.

Aireon Mfg. Corp. reports net income of $750,553 or $1.03 a common share in fiscal year ended Apr. 30, 1945, compared with net income of $1,064,041 or $1.49 a share in previous fiscal year. Company has added five new subsidiaries with assets equivalent to the sum of $700,000 in 1945.

Aircraft manufacturing volume will range from about $850,000,000 in 1946 to well over $1,500,000,000 in 1950, according to CAB estimates. This would compare with less than $300,000,000 annually just before war.

Fairchild Engine & Airplane Corp. sales last year amounted to around $45,000,000 in all divisions, compared with $93,200 in 1944.

ADDING IT UP . . . . . By RAY HOADLEY

International Airlines. Government officials estimate it will be 5 yr. before the whole network of international airlines proposed by CAB will be set up and in operation. Furthermore, they believe it may be 10 yr. before lines will be self-supporting.

Airline Mergers. PCA's merger with Northeast considerably narrows prospects of possible further consolidations in this field. With a merger of AA and Mid-Continent hanging fire, there are only Colonial and Continental left among the smaller lines. Rumor had it that Eastern planned to take over Colonial, but both Eastern and Colonial deny any moves with respect to this line of action.

Personal Planes. Private plane makers anticipate a $100,000,000 business in the coming year, according to estimates of Continental Motors Pres. C. J. Reese. That would mean sales of 35,000 to 40,000 planes in '46. Continental has orders for around 35,000 engines to be delivered in the next twelve months.

Stinson Div. of Convair has raised its production sights. Originally scheduling 2,500 Voyagers next year, the company now hopes to turn out 4,000.

Airline Credit. First long term unsecured credit obtained by a major airline was arranged when TWA sold $30,000,000 of 10 yr. debentures to Equitable Life at 3% interest. Airlines are now regarded with such favor by banking houses that well managed lines can get credit under 2% on short term loans.

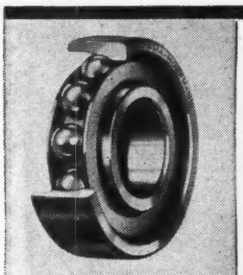
Engine Prices. Aircraft engine prices at close of war were lowest in 10 yr. Now engine makers are back in the tool shop stage, and with wages and material costs considerably higher, trade officials say higher engine prices are inevitable.

Unfilled Orders. East Coast aircraft manufacturers have aggregate unfilled orders of around $580,000,000, of which $120,000,000 represents commercial orders. This compares with unfilled orders of approximately $700,000,000 for the West Coast plants.

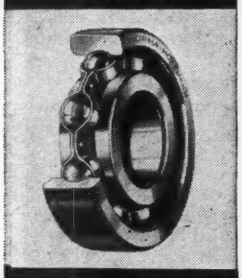
Individual Backlogs. Martin has military contracts of about $90,000,000, plus $17,000,000 in transport orders and $412,000,000 for transport reconverts. . . . Republic officials figure their backlog at better than $50,000,000, including $20,000,000 military, $25,000,000 commercial, and $10,000,000 in transport reconversions. . . . Grumman's military orders are placed in the neighborhood of $60,000,000, while those of Fairchild Engine & Airplane Corp. come to more than $80,000,000. Bell has $16,500,000 in orders; Piper has $11,000,000, and C-W and United Aircraft each have backlogs of well over $100,000,000.

Airline Results. Fourteen major lines reported heavy gains in gross operating revenues for the first nine months of 1945. At the same time profits dropped for several of the largest companies, while the smaller concerns improved their showing over 1944. Gross revenues were $144,780,000 against $106,238,000 the previous year. Net income, however, dropped to $15,266,000 from $15,690,000 in 1944.

PRECISION BEARINGS



Separable (Magneto) Ball Bearing



Single Row Ball Bearing

FOR EVERY LOAD, SPEED AND DUTY

108 DISTINCT SERIES

BALL, ROLLER AND THRUST

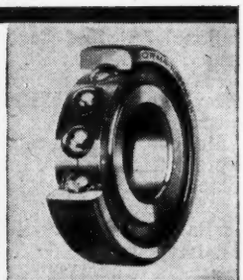
OVER 3000 SIZES

1/8" to 22 1/2" Bore—Metric and Inch Sizes

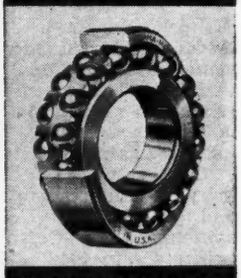
Write for the Catalog and Engineering Counsel

NORMA-HOFFMANN BEARINGS CORP'N. — STAMFORD, CONN., U. S. A.

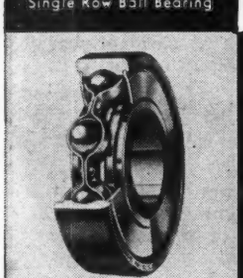
"NORMA-HOFFMANN"



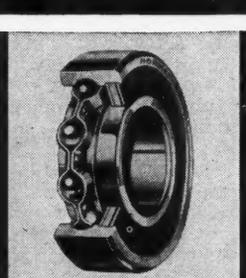
Litro ("CL") Composition Retainer Ball Bearing



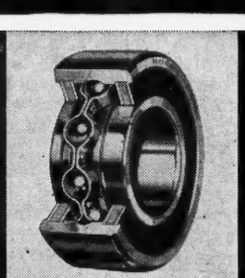
Double Row Self-Aligning Ball Bearing



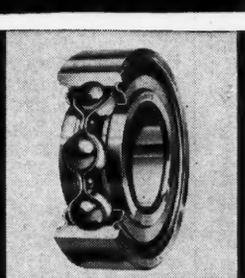
Shielded Type Single Row Ball Bearing



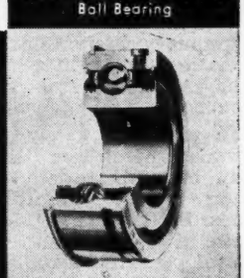
Single Felt Seal Ball Bearing



Double Felt Seal Ball Bearing

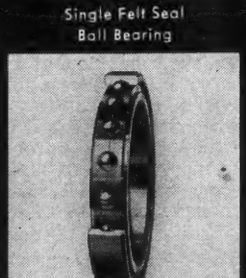


9000 Series (Feltless) Sealed Ball Bearing



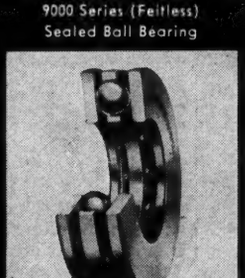
"Cartridge" Fully Sealed, Refillable Type Ball Bearing

Double Row Ball Bearing

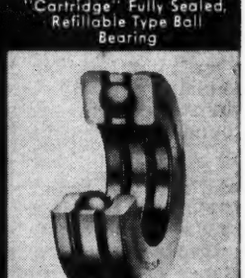


Extra Light Type Ball Bearing

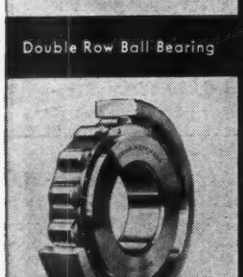
Angular Contact Ball Bearing



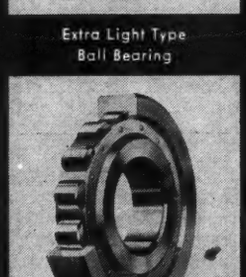
Extra Light Single Direction Ball Thrust Bearing



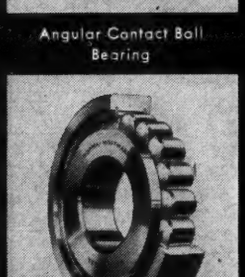
Single Direction Ball Thrust Bearing



Standard Cylindrical Roller Bearing



Type "E" Cylindrical Roller Bearing



Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing

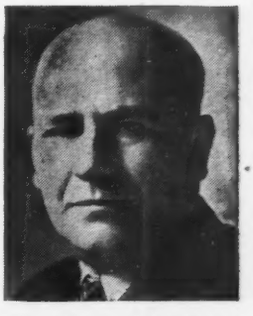
Two-Lipped Cylindrical Roller Bearing

LT. GEN. JAMES H. DOOLITTLE returned to Shell Oil Co. as vice-pres., and he will be a nominee for board of directors at next stockholders' meeting. He will make his hq. in N. Y. and coordinate company's aviation interests. He was formerly mgr. of Shell's aviation dept. (AAF photo)

REP. ROBERT RAMSPECK (D), Georgia, has been appointed to newly created office of vice-pres. of ATA. A leading congressional authority on Civil Service, he has served on many committees during his 16 yr. of office. He has solved many controversies. (Modelle Studios photo)

CAPT. H. C. KRISTOFFERSON has been appointed operations mgr. of PAA's Pacific-Alaska div. Until recently he served as Col., Asst. Chief of Staff, ATC hq. He helped organize transport service across Africa, later headed ATC operations in Middle East Wing and in India-China.

HENRY E. GUERIN retired from Douglas after 25 yr. with company, last five as plant mgr. of Santa Monica plant. Starting as a mechanic, he was one of three originally associated with Donald Douglas when company was formed. His best known contribution to industry is Guerin process.



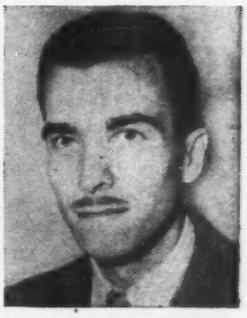
ALLAN F. BONNALIE has been named pres. and general mgr. of LAMSA, Mexican subsidiary of UAL. He began his flying career in 1911, and during World War II served as a commander with Buaer in Washington. He was formerly UAL's asst. to vice-pres., operations.

MAJ. J. KEITH DAVIS has been named sales mgr. of Airplane Sales Div. of Robinson Aviation. Prior to entering AAF in 1942, he was vice-pres. and sales mgr. of Inter City Aviation, pres. of Harvard Flying Club, and a director of National Intercollegiate Flying Clubs. (H. C. Engels photo)

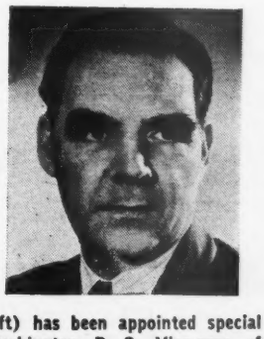
ARTHUR E. RAYMOND has been named head of IAS for '46. Vice-pres., engineering, for Douglas, he is a graduate of Harvard and received his M. S. in aero engineering from MIT. He later became asst. professor of aero at California Institute of Technology. He joined Douglas in 1925.

COL. JESS B. BENNETT has joined Braniff Airways as director of research and planning and will cover every phase of airline's operation. While in service he was executive officer of Craig and Selman Fields, and Lockbourne Army Air Base. He then transferred to ASF.

THEODORE C. COLEMAN, who recently resigned as vice-pres. in charge of sales for Northrop, left for Brazil to start his own business. Named South American distributor for Northrop Aircraft and Northrop Aero Institute, he also expects to open an aircraft service and maintenance base.



EUGENE W. NORRIS has been made chief engineer for Luscombe. Formerly technical director for AIA, he is a graduate of Guggenheim School of Aero, is a personal pilot, and a member of AOPA, IAS, and Aero Club of Washington. He has been with several aircraft makers.



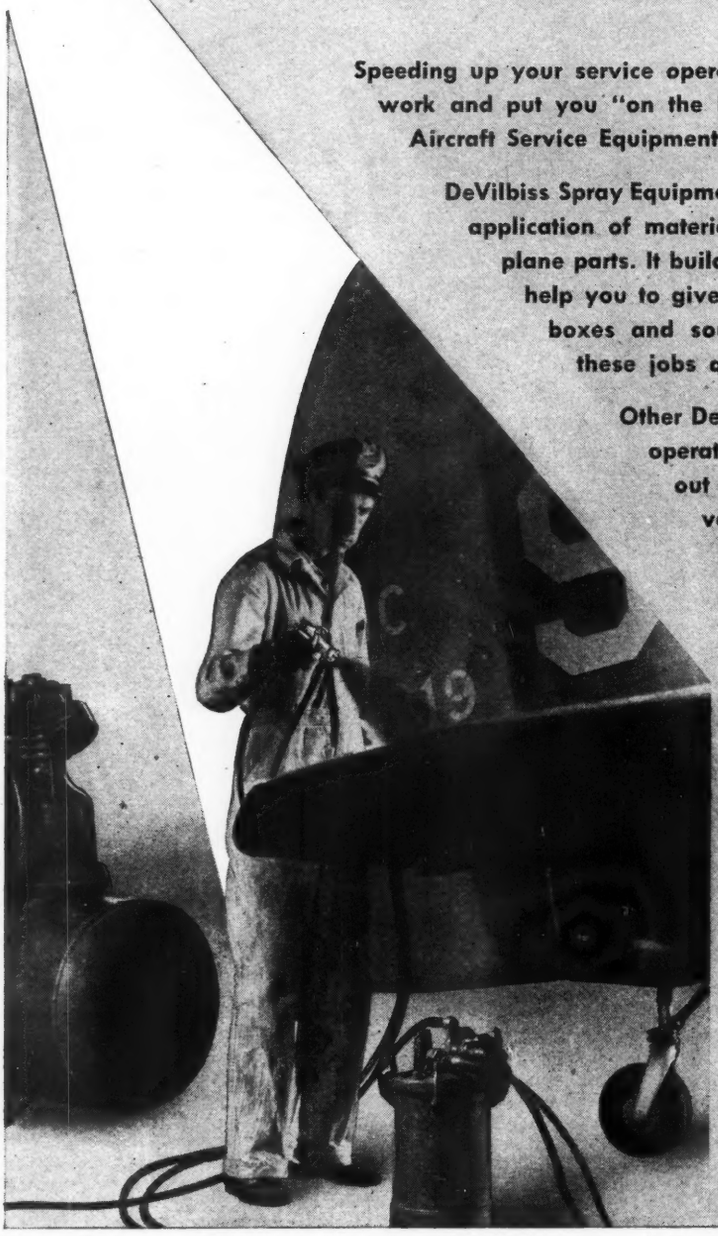
RICHARD C. PALMER (left) has been appointed special asst. to pres. of Fairchild and will have his hq. in Washington, D. C. Vice-pres. of NAA in charge of defense council, he was also at one time general mgr. of NAWPC. A graduate of Denison University, he later received a law degree, cum laude, from University of Denver. **HARRY M. McKAY** (center) was named head of company's new Personal Planes Div. In aviation since '25, he became vice-pres. of St. Louis Aircraft in '38, in charge of engineering and production. From that post he came to Fairchild in '44. **LEE H. SMITH** (right) was appointed to direct sales of new div. He learned to fly at Kelly Field in '17, and since has been active in personal planes sales, having been connected with Stinson, Vultee, Waco, and Aeronca. He joined Fairchild in '42 as general mgr. of Burlington plant. (Tommy Weber photos)

COL. ROBERT M. LOVE has been selected as new pres. of All American Aviation. Widely known in aviation, during war he served in ATC. Prior, he was pres. of Inter City Aviation and a member of Mass. State Aero Commission. Educated at Princeton and MIT. (AAF photo)

COL. SILAS R. RICHARDS has been elected TACA vice-pres. in charge of operations. Before joining AAF, he was a UAL pilot. He has been awarded Legion of Merit (for his part in directing airborne invasion of France), Bronze Star, and Croix de Guerre. In 1945 he transferred to ATC.

DEVILBISS AIRCRAFT SERVICE EQUIPMENT

A line that is beamed to SPEED SHOP WORK!



Speeding up your service operations will enable you to take on extra shop work and put you "on the beam" to bigger profit. That's what DeVilbiss Aircraft Service Equipment can do for you—and service records prove it.

DeVilbiss Spray Equipment can save you time on all work requiring the application of materials, from cementing wing fabrics to painting plane parts. It builds dope finishes faster with fewer coats. It will help you to give added service, such as acid proofing battery boxes and sound deadening planes—and it will do all of these jobs quickly.

Other DeVilbiss Equipment can speed up such cleaning operations as degreasing engine parts and blowing out fuel lines. It makes work easier and faster by ventilating shop areas and supplying plenty of compressed air for all needs. It will reduce hose repairs and save time with quick detachable hose connections.

Here's a reliable lead to faster, better and economical service operations. Be sure to get the details about the business-building DeVilbiss Line from your distributor—or write the factory.

The DeVilbiss Company, Toledo, Ohio

Canadian Plant: Windsor, Ontario

This DeVilbiss Spray Equipment used by a fixed base operator in the South saves at least 50% in time and labor on a wide variety of painting work.

DE VILBISS

means Quality *in all four..*

SPRAY EQUIPMENT
EXHAUST SYSTEMS
AIR COMPRESSORS
HOSE & CONNECTIONS

NEW PRODUCTS

KEEP POSTED ON
Products and Practices

INFORMATION TIPS

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING DATA

Tubing Data Book.....1

Several new charts for insertion in AIRCRAFT TUBING DATA BOOK are available from **Summerill Tubing Co.**, Bridgeport, Pa. Sheets show column charts for alloy tubing, also internal pressures on stainless steel tubing for hydraulic lines.—AVIATION, Jan., '46.

Precious Metals Parts.....2

Conversion of precious metals into parts for aircraft magnetos, voltage regulators, instruments, and controls is described in folder from **Baker & Co.**, Newark, N. J.—AVIATION, Jan., '46.

Metal Products Fabrication.....3

Describing new techniques and processes in fabricating and beautifying metal products and assemblies, METAL CRAFT BROCHURE, from **L. F. Grammes & Sons**, Allentown, Pa., covers details of company's contract service to aviation manufacturers.—AVIATION, Jan., '46.

Metallic Friction Materials.....4

General Metals Powder Co. has issued circular describing "Gempco" powdered metallic friction materials for use in clutch and brake designs.—AVIATION, Jan., '46.

Piping Vibration Eliminators.....5

FUNCTIONAL SPRING HANGERS AND VIBRATION ELIMINATORS is title of booklet from **Blaw-Knox Co.**, Pittsburgh, offering conclusions of power piping engineers on designs of piping layouts.—AVIATION, Jan., '46.

Packings Manual 6

Graton & Knight Co., Worcester, Mass., has issued new MECHANICAL PACKINGS MANUAL, handbook containing basic information required by design engineer. A charge ($4.50) is made for this work.—AVIATION, Jan., '46.

Zinc Alloy Castings.....7

Dealing exclusively with civilian applications of zinc alloy die castings, Vol. 13 No. 3 of THE ALLOY POT, publication of **New Jersey Zinc Co.**, New York City, contains diversified information for design engineers.—AVIATION, Jan., '46.

Masonry Material 8

Facts and suggestions on materials and construction methods for tanks, towers, sumps, floors, and other masonry construction, are contained in booklet from **U. S. Stoneware Co.**, Akron. Title is CORROSION-RESISTANT MASONRY MATERIAL AND CONSTRUCTION MATERIAL.—AVIATION, Jan., '46.

PRODUCTION

Fiber Packing Boxes.....9

Booklet from **Weatherproof Solid Fibre Box Group**, Washington, D. C., reports on wartime development and performance record of fiber packing boxes.—AVIATION, Jan., '46.

Air and Hydraulic Cylinders.....10

All-steel heads, caps, and separate interchangeable steel mountings, replacing castings formerly used in air and hydraulic cylinders, are described by **Miller Motor Co.**, Chicago, in Bulletin A-103.—AVIATION, Jan., '46.

Pipe Sealer 11

"Black Magic" pipe sealing compound and gasket cement is described in pamphlet from **Bowser, Inc.**, Fort Wayne, Ind.—AVIATION, Jan., '46.

Aircraft Forgings 12

Dealing with employment of forgings for overcoming difficulties of combining strength and toughness with economy of size and weight, FORGINGS FOR AIRCRAFT, publication from **Steel Improvement & Forge Co.**, Cleveland, describes four types of forgings suitable for aircraft parts.—AVIATION, Jan., '46.

Thermoplastic Tapes 13

Properties of "Resinite" compounds, and description of tapes, tubing, and tying cord made of this material, are given in circular from **Resin Industries**, Santa Barbara, Calif.—AVIATION, Jan., '46.

Threading-Stamping Process 14

Bulletin No. 1 from **Tubing Seal-Cap, Inc.**, Los Angeles, describes "Thredstamp" process of combining precision threading and stamping in one process.—AVIATION, Jan., '46.

Polishing and Buffing Materials.....15

Description and applications of industrial finishing materials are contained in POLISHING, BUFFING, AND BURRING, reference manual from **McAleer Mfg. Co.**, Rochester, Mich.—AVIATION, Jan., '46.

Identification Labels 16

Sample card and literature are offered by **W. H. Brady Co.**, Milwaukee, describing "Quik-Labels" for use in marking or coding wires, motor leads, harnesses, circuits, conduits, relays, coils, terminal boards, fuse blocks, and cables.—AVIATION, Jan., '46.

Ducting Material 17

Arrowhead Rubber Co., Los Angeles, has issued circular describing "Airtron", glass cloth and rubber ducting material for aircraft heating and ventilating and other uses. Material is described as having high insulation qualities and great flexibility.—AVIATION, Jan., '46.

Forgings 18

Brass and aluminum forgings, also equipment in which they were used in the war by AAF, are illustrated in November issue of NON-FERROUS FORGINGS DIGEST, issued by **Brass Forging Assn.**, New York City.—AVIATION, Jan., '46.

AVIATION READERS' SERVICE

JANUARY 1946

AVIATION, 330 W. 42nd St., New York City 18

Please send me additional information according to key numbers circled.

INFORMATION TIPS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68

NEW PRODUCTS: 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109

NAME ..... TITLE .....

FIRM OR AFFILIATION .....

ADDRESS .....

Wire Baskets 19

Wire boxes and baskets for processing, heat treating, and toting are described in folder from **Hoffman Co.**, York, Pa.—AVIATION, Jan., '46.

Dry Air Pump 20

Lightweight motor-driven dry air pump is described in folder from **Eclipse-Pioneer Div., Bendix Aviation Co.**, Teterboro, N. J. —AVIATION, Jan., '46.

Spherical Bearing 21

Now available to manufacturers of equipment using self-aligning bearings is "Halfco" spherical bearing, used in military aircraft. Maker is **Halfco Engineers**, Los Angeles.—AVIATION, Jan., '46.

Production Service 22

Company's facilities for manufacturing production parts and unit assemblies for others is described in folder from **Ex-Cell-O Corp.**, Detroit.—AVIATION, Jan., '46.

Large Blind Rivets.....23

Cherry Rivet Co., Los Angeles, announces blind rivets in new large 7/32, 1/4, and 9/32 in. diameter sizes.—AVIATION, Jan., '46.

MACHINERY & ACCESSORIES

Rotary Actuator 24

New catalog page for insertion in Catalog EM-200 is being issued by **Lear, Inc.**, Grand Rapids, Mich. Described is new, small rotary actuator for remote actuation of valves, shutters, controls, and similar applications.—AVIATION, Jan., '46.

Boring Machine 25

Model C Autometric boring machine, product of **Kearney & Trecker Products Co.**, Milwaukee, is described in Catalog CMA 10.—AVIATION, Jan., '46.

Electric Lift Truck.....26

Catalog from **Yale & Towne Mfg. Co.**, Philadelphia, describes new "Worksaver" electric truck for handling factory materials.—AVIATION, Jan., '46.

Vibration Tester 27

"Vibrok" vibration and rocker testing machines, made by **Globe Industries**, Dayton, Ohio, are described in circular.—AVIATION, Jan., '46.

Commutator Saw 28

Made with steel hub permanently bonded to carboloy cemented carbide blade, new commutator slitting saw, designed to eliminate fracturing, is described in circular from **Gay-Lee Co.**, Ferndale, Mich.—AVIATION, Jan., '46.

Grinder Coolant Filter.....29

Bulletin concerning new grinder coolant filter which features replaceable (bag-type) filter element, is available from **Cuno Engineering Corp.**, Meriden, Conn.—AVIATION, Jan. '46.

Shock Tester 30

Designed to read value of max. intensity of shock, even though max. exists for extremely short duration, G-Meter, manufactured by **Frederic D Schottland**, Kew Gardens, N. Y., is described in literature.—AVIATION, Jan., '46.

Vibration Test Machines.....31

Vibration test equipment made by **L.A.B. Corp.**, Summit, N. J., is topic of folder describing machines in detail.—AVIATION, Jan., '46.

C-Clamp 32

Locking or unlocking with quarter turn of handle, and equipped with shield, new "Bar-Lok" C-clamp manufactured by **Mechanics Engineering Co.**, Jackson, Mich., is described in pamphlet.—AVIATION, Jan., '46.

Welding Electrode 33

Views of typical welds and tests, weld deposit physical properties, procedure, and illustrative applications are given in Bulletin W-7, describing "Phos-Trode," shielded arc, phosphor bronze welding electrode made by **Ampco Metal**, Milwaukee.—AVIATION, Jan., '46.

Gages 34

In folder, **AA Gage Co.**, Detroit, describes line of plug and ring gages, setting disks, and special built-up gages and fixtures. Also described are gage salvaging and gage block inspection services. — AVIATION, Jan., .46.

Imported Tachometers 35

Universal type hand tachometer, Type U, with five ranges, imported from Switzerland, is described in Bulletin No. 750, from **Herman H. Sticht Co.**, New York City.—AVIATION, Jan., '46.

Involute Checkers 36

For accurately checking profiles on spur and helical gears, Models 1124 and 1124-C "Sine-Line" involute checkers are described in technical Bulletin No. 1124-45 from **Michigan Tool Co.**, Detroit.—AVIATION, Jan., '46.

Conveyors 37

ACHIEVE MAXIMUM EFFICIENCY IN HIGH SPEED PRODUCTION is title of booklet from **Standard Conveyor Co.**, No. St. Paul, Minn., in which applications for aircraft and other manufacturing plants are given.—AVIATION, Jan., '46.

Hack Saw Care.....38

Booklet issued by **Victor Saw Works**, Middletown, N. Y., titled METAL CUTTING, offers suggestions on selection, care, and use of power hack saw blades.—AVIATION, Jan., '46.

Four-Way Control Valve.....39

Designed for control of air and low pressure hydraulic systems, "Modernaire" 4-

AIR COMPRESSORS · HOSE REELS · AIR SCALES · LIFTS · CAR WASHERS
GASOLINE
THIS SALE
GALLONS
PER GALLON
THE BIG NEWS
WAYNE COMPUTING TYPES
AIRCRAFT REFUELERS . . .
SELLS
OIL, TOO
READY for the "age of air" just ahead . . . the Wayne Airport "service station" in a single compact, streamlined cabinet. It computes and records the sale like an automotive gasoline pump . . . incorporating the same time-tested units plus self-retrieving hose reel and many new refinements. All complete ready to install. Sells oil, too, from shelves holding three cases of quart cans. Write today for bulletin and prices.
THE WAYNE PUMP CO., FT. WAYNE 4, IND.
WAYNE Airplane REFUELING SYSTEMS

Remember this of

SUPERIOR

SMALL METAL TUBING*

1. No finished stocks are carried at the mill. Every order is made as it is received.
2. In most cases, we furnish cut or random lengths, with no fabricating.
3. Bright finish is assured, by use of controlled atmospheres in annealing.
4. Every order is given laboratory tests for approval before shipping.
5. Superior has three standard tempers: Temper =1 is annealed, Temper =2 is half-hard, and Temper =3 is full-hard.

*Seamless . . . in many metals.
Weldrawn . . . welded and drawn in various stainless analyses as well as "Monel" and "Inconel".

SUPERIOR

THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless, "Monel" and "Inconel"

SEAMLESS and Patented LOCKSEAM Cathode Sleeves

way control valve, Model CV series, is described in bulletin from **Modern Products,** Los Angeles.—AVIATION, Jan., '46.

Electrode Holders 40

Developed for manual welding, new line of air cooled carbon electrode holders in 150, 200, 300, and 500 amp. models, is described in bulletin from **Tweco Products Co.,** Wichita, Kan.—AVIATION, Jan., '46.

Automatic Index Base.....41

Containing illustrations of company's automatic index base, specific applications, features, and engineering data, circular from **Sundstrand Machine Tool Co.,** Rockford, Ill., is titled HOW TO INCREASE PRODUCTION, IMPROVE ACCURACY, ELIMINATE MANUAL INDEXING.—AVIATION, Jan., '46.

Cutting Electrodes 42

Bulletin from **Ellwood Products Corp.,** Ellwood City, Pa., contains details, specifications, and instructions for use of "Ellpro" cutting electrodes, for surface or underwater cutting.—AVIATION, Jan., '46.

Die Casting Machine.....43

Brochure, DIE CAST YOUR PRODUCT, from **H. L. Harvill Mfg. Co.,** Vernon, Calif., contains information on process and description of equipment, including four new machines of "package plan" type.—AVIATION, Jan., '46.

Chuck Catalog 44

Catalog No. 58, from **Skinner Chuck Co.,** New Britain, Conn., contains 95 pages of illustrations, descriptions, and specifications on company's line of chucks.—AVIATION, Jan., '46.

Foundry Equipment Catalog.....45

Available from **American Foundry Equipment Co.,** Mishawaka, Ind., is revised edition of reference catalog describing full line of blast, metal washing, dust collecting, and sand cutting equipment.—AVIATION, Jan., '46.

Engine Timer 46

Gabb Mfg. Co., E. Hartford, Conn., has issued new folder descriptive of "Time-Rite," instrument designed to speed piston positioning of aircraft engines and various operations of timing, including ignition and checking of valve openings.—AVIATION, Jan., '46.

Parts Cleaning System.....47

Catalog from **Gray-Mills Co.,** Evanston, Ill., describes line of parts cleaning machines and "Agitene" solvents. Included are three new parts cleaning systems: Model H-71, general utility unit; Model J-75, for hose cleaning engine blocks and other large parts; and Model L-73, portable unit for carburetors and other small parts. —AVIATION, Jan., '46.

Portable Spotwelders 48

Bulletin No. 122-A, from **Sciaky Bros.,** Chicago, describes new line of overhead type portable spotwelding units, pneumatic and hydraulic, available with transformer ratings of 50, 75, and 100 kva.—AVIATION, Jan., '46.

Magnet Strength Measurement.....49

Information is available on direct-reading fluxmeter developed for precise measurement of field strengths of magnets used with magnetron assemblies. Maker is **Marion Electrical Instrument Co.,** Manchester, N. H.—AVIATION, Jan. '46.

Machine Control Unit.....50

Brochure from **Bullard Co.,** Bridgeport, Conn., contains description and specifications of "Man-Au-Trol" automatic machine control unit applied to company's vertical turret lathe, horizontal lathes, and chucking machines.—AVIATION, Jan., '46.

Pneumatic Relay 51

Hagan Corp., Pittsburgh, offers Bulletin 5145 describing new Type F totalizer—pilot-operated pneumatic relay used to add or subtract loading pressures received from exterior sources. Device is also used as regulator.—AVIATION, Jan., '46.

Metallizing Gun 52

Bulletin 49 P, from **Metallizing Engineering Co.,** Long Island City, N. Y., describes new Type Y heavy-duty metallizing gun for continuous operation. Unit is geared for mounted, mechanical operation.—AVIATION, Jan., '46.

High Pressure Cleaner.....53

Folder from **Drill Mfg. Co.,** Indianapolis, describes new high pressure cleaning and degreasing machine combining cleaning and degreasing with a pre-soaking unit. Model No. 1 is portable and plugs into light socket. AVIATION, Jan., '46.

ELECTRICAL

Fine Wire 54

Titled FINE WIRE OF SPECIAL MATERIALS, article from **North American Philips Co.,** New York City, concerns manufacturing wires of 0.002 to 0.0007 in. dia., and smaller. Subjects covered are: Steps in producing die, drawing wire, checking methods, and X-ray diffraction examination of atomic structure.—AVIATION, Jan., '46.

Rotary Solenoids 55

Information on "Ledex" rotary solenoids, which are applied to remote controls and special power units, is given in 8-page Booklet No. 100 issued by **George H. Leland,** Dayton, Ohio.—AVIATION, Jan., '46.

Pressurized Receptacles 56

Improved pressurized connector receptacles in both "AN" and "K" types, for use in pressurized cabins and elsewhere, are listed in special bulletin from **Cannon Electric Development Co.,** Los Angeles.—AVIATION, Jan., '46.

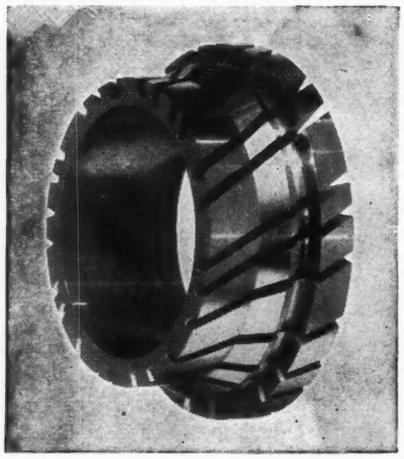
Stroboscopic Light Source.....57

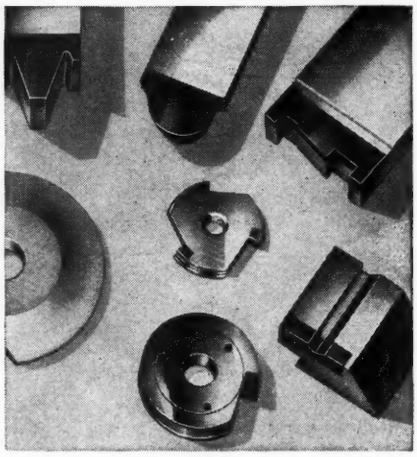
Vol. 20, No. 5, of EXPERIMENTER,

NOW CRUSH DRESSING OF GRINDING WHEELS ... by Perfex

THIS REVOLUTIONARY NEW METHOD of dressing grinding wheels, with its much greater accuracy and increased speed, is taking industry by storm.

Perfex is especially pleased to announce that we can now furnish you crusher rolls (both thread and form) made to your own specifications.





Typical crusher roll shown above, will dress your grinding wheel in a fraction of the time previously required and with greater accuracy.

Perfex is also prepared to offer you Carboloy or high speed steel circular, flat or dove-tail forming tools such as those shown above.

If you are not already familiar with the story of crush dressing of grinding wheels, we will be glad to answer your questions. Write us today or ask for quotations.

PERFEX GAGE & TOOL COMPANY
3609 GAYLORD AVENUE DETROIT 12, MICHIGAN

ACCURACY PERFEX OUR CREED

"TRANSFAX laid out all these parts on one plate . . . *in only 8 minutes!*"

Let Transfax put your drawings directly on metal, plastics, rubber... along with precise instructions for cutting, drilling, or welding

In operations of from a few to several thousand industrial units, the Kodak TRANSFAX PROCESS wins approval for speeding production . . . makes previously unheard-of savings in time and labor . . .

With line-for-line accuracy, Transfax puts the original drawings from your Engineering Department directly on the metal, plywood, plastics, or rubber . . . ends laborious scribing . . . ends costly, time-consuming errors.

Where layouts and templates are complex . . . where instructions as well as dimensions should be on every piece to be fabricated . . . where accurate lines and points are needed to guide the welder or the man at the drill-press or cutting machine . . . the value of Transfax goes unchallenged. And Transfax withstands rough handling. Even the cutting torch won't erase it except by direct contact.

Transfax is surprisingly simple to install. No special equipment is needed. No special training of workers. In any ordinary room—using a spray gun, a watering hose, and an arc or mercury vapor lamp, Transfax gets big, 8-foot plates ready for fabrication *in 8 minutes!*

For full information on this revolutionary, new Transfax Process, clip and mail the coupon *today*. Now is the time to begin taking advantage of the economies of Transfax.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

TRANSFAX

SAVES TIME • ENDS ERROR
SPEEDS PRODUCTION

FREE FOLDER—CLIP COUPON

Gentlemen: I want to know more about TRANSFAX, its many applications and economies. Please send my copy of the folder to:

NAME_____

STREET_____

CITY_____ ZONE_____ STATE_____

Kodak

BRIGGS & STRATTON ENGINES

"PREFERRED POWER"

THE WORLD OVER

EACH year for over a quarter of a century Briggs & Stratton has been the largest producer of single cylinder, 4-cycle, air-cooled gasoline engines. This continued demand for more and more of these engines is a tribute to their dependable and economical operation — from users, dealers and producers of powered equipment the world over — and also an appreciated tribute to the men and women of Briggs & Stratton who build them. You can buy Briggs & Stratton powered equipment confident of receiving the utmost in engine performance.

BRIGGS & STRATTON CORPORATION
MILWAUKEE 1, WISCONSIN, U. S. A.

Air-Cooled Power

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

publication of **General Radio Co.**, Cambridge, Mass., contains article on "Microflash," light source for photographic exposures of the order of 2 microseconds.—AVIATION, Jan., '46.

Portable Test Sets 58

Complete line of portable, a.c. test sets from 2,000 to 150,000v. is described in Bulletin GEA-4477, from **General Electric Co.**, Schenectady, N. Y.—AVIATION, Jan., '46.

Input Controller 59

Design to provide accurate control of electric furnaces and ovens, new electric type proportional-current input controller, is described in Bulletin PB1226, from **The Bristol Co.**, Waterbury, Conn.—AVIATION, Jan., '46.

PLASTICS

Air-Drying Plastic Film 60

Information is available on "Corrosite," stated to be practically impermeable air-drying film. Product is described as resistant to most acids, all alkalies, and many chemicals. Maker is **Baker Synthetics**, New York City.—AVIATION, Jan., '46.

Acrylic Plastics 61

Manual from **Rohm & Hass**, Philadelphia, contains authoritative information on proper handling of acrylic plastics. Titled HOW TO DESIGN IN CLEAR PLASTICS, 56-page work is seen useful to a wide field, from disabled veteran to commercial designer.—AVIATION, Jan., '46.

Plastic Developments 62

PLASTICS NEWSFRONT is new house organ of **Plastics Div. of American Cyanamid Co.**, New York City. It deals with applications of molding compounds, resin adhesives, and laminating resins. Regular features will include "The Plastic Designers Corner" and "Shop Talk."—AVIATION, Jan., '46.

Plastic Engineering 63

Watertown Mfg. Co., Watertown, Conn., has issued THE WATERTOWN BOOK OF PLASTICS containing description of company's services in designing, selection of materials, and manufacture of parts. Included is description of various types of plastics, with charts for comparison.—AVIATION, Jan., '46.

PLANT SERVICE

Industrial Tires 64

Description of various types of industrial tires, information on care and maintenance, and specifications, are given in HOW TO SAVE MONEY ON INDUSTRIAL JOBS AND EQUIPMENT, booklet from **B. F. Goodrich Co.**, Akron.—AVIATION, Jan., '46.

AIRPORTS

Packaged Radio Station 65

Described in folder from **Aireon Mfg. Corp.**, Kansas City, Mo., is complete 50 w. radio station, ready for use when plugged in to power socket. Operation may be from point to point, ground to plane, or as tower control station.—AVIATION, Jan., '46.

MANAGEMENT & EMPLOYEES

Machine Shop Terms 66

GLOSSARY OF MACHINE SHOP TERMS, booklet issued by **Kropp Forge Co.**, Chicago, defines words and terms as used in heavy machine shop practice.—AVIATION, Jan., '46.

Tax Chart 67

Details of withholding tax requirements are covered in new edition of DELBRIDGE SIMPLIFIED WITHHOLDING TAX CHART, issued by **Delbridge Calculating Systems**, St. Louis. A charge ($2.50) is made for book.—AVIATION, Jan., '46.

Instrument Dials 68

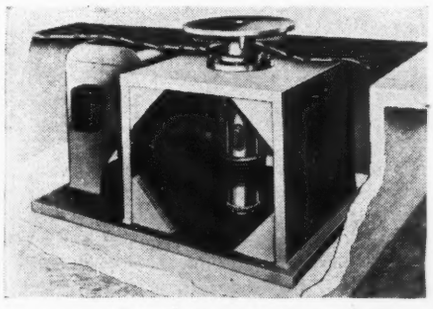
Photographic process of producing instrument dials is described in bulletin from **American Dial Co.**, New York City.—AVIATION, Jan., '46.

NEW PRODUCTS

Machinery & Accessories

Centrifugal Casting 69

Designed for heavier off-balance loads, continuous high production, and free-spinning power, "Master Centri-Meco" centrifugal casting machine is announced by **Centrifugal Machine & Engineering Co.**, Kalamazoo, Mich. Weighing 3,700 lb. net, it is so designed that standard 24 in. spinning head may be extended to 60 in. dia. by means of adapter plate. Molds may be



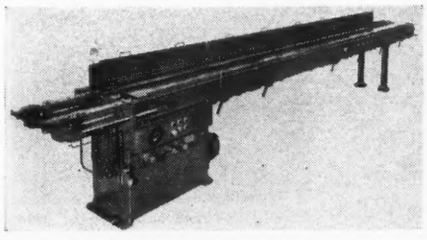
stacked to any workable height. Hub is turned out of 7 in. mechanical tubing of ¾ in. thickness. It is stated to provide for a continuous production operation with permanent molds attached to table mounting-plate. Table has strut-vanes to carry away excess heat, holding temperature in bearing area to less than 125 deg. F. Speeds are adjustable, and dynamic braking is obtainable. Electronic drives may be installed.—**AVIATION, Jan., '46.**

Milling Machine 70

Features of new No. 3 horizontal milling machine announced by **Van Norman Co.**, Springfield, Mass., are: Table 64 x 14 in., large fly-wheel mounted on spindle inside column, broad and heavy base, column with internal ribbing, ram-type overarm with dove-tail ways bearing on column, improved cam-type gibbing locks ram to column both front and rear, pilot wheel which positions overarm, arbor supports equipped with oil reservoirs, front and rear directional control of all power feeds, provision of hand feeds both front and rear, single lever speed and feed selectors for easy selection of 18 speeds or 18 feeds, and automatic lubrication. Drive motor is 7½ hp., table travel longitudinal 34 in., saddle cross feed 12 in., knee vertical feed 17 in.—**AVIATION, Jan., '46.**

Tensile Strength Tester.....71

Adaptable to testing tensile strength or modulus of elasticity of variety of metal products, such as chains, wires, cables, or bar stock, tensile strength tester manufactured by **John S. Barnes Corp.**, Rockford, Ill., is 25 ft. long and it accommodates stock up to 20 ft. Adjustable platforms eliminate sag. Two low friction cylinders provide



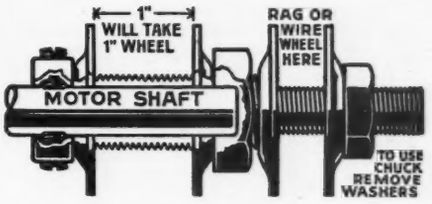
initial test loads up to 1,500 lb. Final test loads may be as great as 15 tons. One chain or cable may be tested while another is being prepared. Safety cover protects operator. Timing device automatically removes test load. Elongation is registered automatically on verniers, which may be reset to zero during test, and which retain max. readings until reset.—**AVIATION, Jan., '46.**

Hydraulic Press 72

Available with self-contained motor drive for production work, new line of foot-operated self-contained hydraulic presses in 4½, 7, 10, 15, 20, and 25-ton cap. has been developed by **Munton Mfg. Co.**, Franklin Park, Ill. Pressure gages help determine pressures being applied. Holding valve may be ordered, enabling press to be used for molding or glue weld operations. Presses are designed for use in push-broaching, forming, blanking, and drawing squeeze assembly of bushings. Rams are interchangeable, offering wide range of possibilities on one press.—**AVIATION, Jan., '46.**

Combination Arbor 73

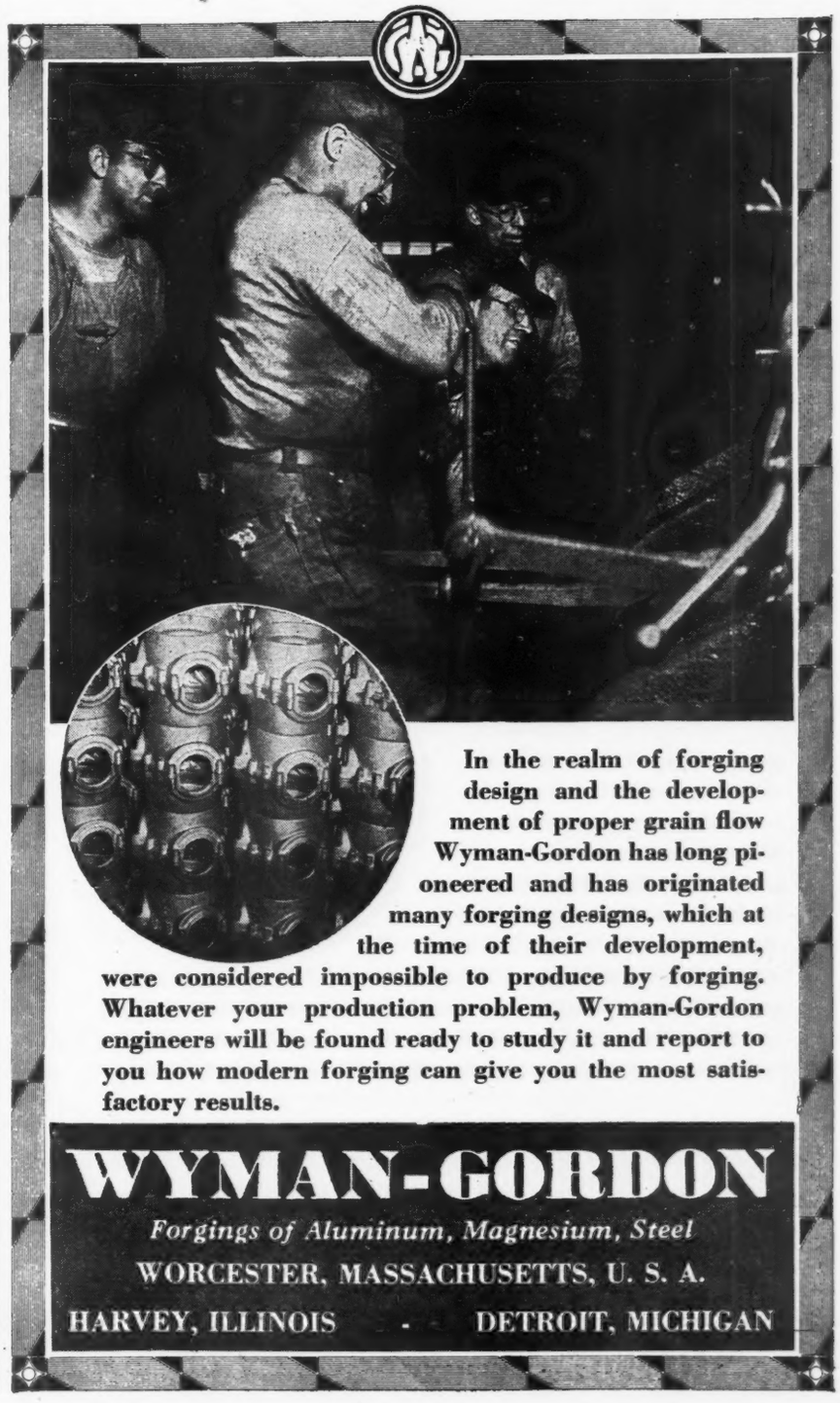
Designed to take grinding wheels with ¾ in. holes on main shaft, or ½ in. holes on small ends, combination attachment arbor for ½ in. electric motor shafts has been developed by **A. D. McBurney**, Los Angeles. Extension can be used for rag or wire wheels, or for circular saw blades.



Extension also holds ½-in. 24-thread drill chucks, which in turn grip drills from No. 60 to those of ½-in. dia. "Super" arbor No. 150 fits well over and onto main motor shaft, so that a 1-in. wheel is thus mounted on main shaft instead of on extension.—**AVIATION, Jan., '46.**

Piston Ring Gage.....74

Described as reducing inspection costs and insuring higher uniform quality, new



In the realm of forging design and the development of proper grain flow Wyman-Gordon has long pioneered and has originated many forging designs, which at the time of their development, were considered impossible to produce by forging. Whatever your production problem, Wyman-Gordon engineers will be found ready to study it and report to you how modern forging can give you the most satisfactory results.

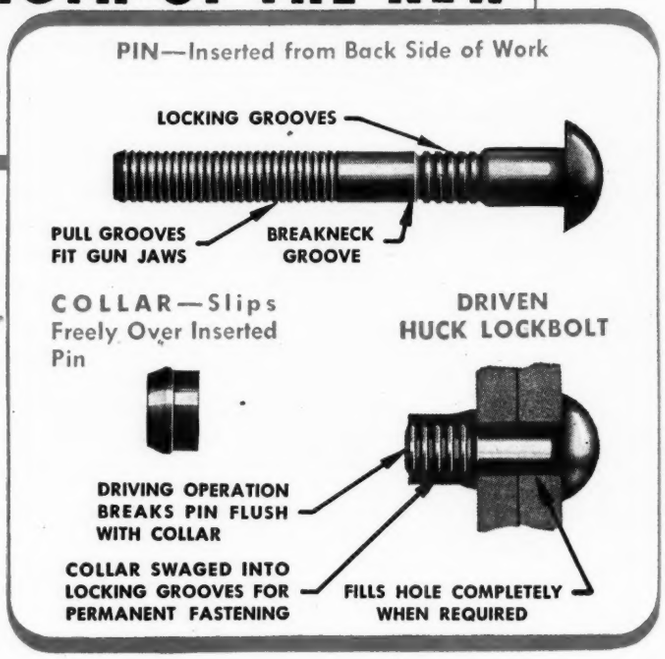
WYMAN-GORDON

Forgings of Aluminum, Magnesium, Steel

WORCESTER, MASSACHUSETTS, U. S. A.

HARVEY, ILLINOIS - DETROIT, MICHIGAN

AN ALUMINUM ALLOY FASTENER TO MATCH THE STRENGTH OF THE NEW *High Tensile* ALUMINUM ALLOYS


PIN—Inserted from Back Side of Work
LOCKING GROOVES
PULL GROOVES FIT GUN JAWS
BREAKNECK GROOVE
COLLAR—Slips Freely Over Inserted Pin
DRIVEN HUCK LOCKBOLT
DRIVING OPERATION BREAKS PIN FLUSH WITH COLLAR
COLLAR SWAGED INTO LOCKING GROOVES FOR PERMANENT FASTENING
FILLS HOLE COMPLETELY WHEN REQUIRED

HUCK LOCKBOLTS with pins of ***75S-T aluminum alloy*** provide an ideal means for obtaining full-strength joints of both Alcoa 75S-T and Reynolds R303, thus permitting full utilization of the high physical properties of these new alloys. Quickly driven by either a pneumatic or hand gun, they pull the work together tightly as would a bolt — fill the hole completely where required — then lock in place with the permanence of a rivet.

Huck Lockbolts of ***24S-T*** aluminum alloy offer the same installation advantages and provide the strength of 24S-T rivets without "iceboxing." Other materials are also available as listed below.

Used in place of RIVETS, the Huck Lockbolt eliminates all bolting-up operations —thus permits much faster assembly. When the shank of the Lockbolt pin is larger than the hole, the pin is drawn into a press fit engagement, thus assuring positive and complete hole-filling with liberal hole size tolerances.

Used in place of BOLTS, Huck Lockbolts save much time and trouble. They are more quickly installed than bolts — eliminate lockwashers, cotterpins and nuts — provide hole-filling — assure uniform tightening — and fasten ***permanently;*** will not loosen under any conditions of vibration or fatigue loading.

Small hand gun is ideal for maintenance jobs. 6 to 10 Lockbolts per minute can be driven with this tool.

SPECIFICATIONS

Huck Lockbolts are available in two types—(1) for applications requiring hole-filling (to replace rivets and close-fitting bolts), and (2) for use in place of bolts in clearance holes. They are furnished with any type of head desired, and with pins of 24S-T or 75S-T aluminum alloy, carbon steel, or high-strength alloy steel.

Lockbolts are now available in 3/16" diameter with grip lengths ranging from 1/32" to 21/32" by 16ths. Lockbolts of 1/4" and 5/16" diameter will soon be available. Full information on request.

Fast, light-weight pneumatic gun recommended for production work will drive 20 to 40 Lockbolts per minute.

Huck MANUFACTURING CO.

2480 BELLEVUE AVENUE DETROIT 7, MICHIGAN

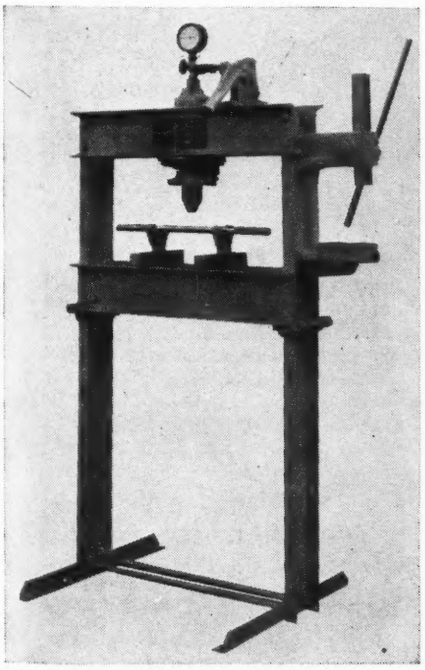
automatic piston ring inspector developed by **Sheffield Corp.**, Dayton, Ohio, automatically segregates rings into three groups: Acceptable periphery and gap; reject gap; and reject periphery because of failure to meet requirements. Operator has but to load rings into feeding device.—**AVIATION, Jan., '46.**

Flexible Tool Holder.....75

Floating in oil-resistant Neoprene, new self-aligning flexible tool holder is described as suitable for follow-up work on turrets of screw machines, engine lathes, and drill presses. Made by **Burg Tool Mfg. Co.**, Los Angeles, holder is designated Model B.—**AVIATION, Jan., '46.**

Hydraulic Press 76

Self-contained and portable, and with power applied by hand operation, new 25-ton hydraulic press, made by **Mech-Arts Products Corp.**, York, Pa., has table travel



of 35 in. and ram travel of 4½ in. Ram dia. is 2¾ in., with width between table channels of 5⅛ in. Overall height is 60 in., floor space required 34 x 27½ in., and weight is 420 lb.—**AVIATION, Jan., '46.**

Vibration Stopper 77

Designed to curb vibration in machinery of any size and weight, and to level machines, "Vibro-Levelers," synthetic rubber devices made by **Bushings, Inc.**, Royal Oak, Mich., may be installed without floor cutting or fitting. Made in nine sizes for loads of from 10 lb. to 2,000 lb. each, they are installed with brackets without materially raising elevation of machine. Rubber insulating material separates an outer shell (which forms base of mounting) from an inner cylindrical member, to which is fastened a single stud. Of two nuts supplied, one is for leveling machine, the other for locking in position. Devices are stated to require no maintenance attention.—**AVIATION, Jan., '46.**

Lathe Angle Plate.....78

Virtually a tool maker's angle plate mounted on an adjustable base for attachment to face plate of lathe, new lathe angle plate, offered by **Madco Products,** New York City, is stated to make it possible to machine off-set inside and outside diameters, bushings and die plates, and irregular shaped castings without special fixtures. Angle plate is L-shaped, with side face 5⅛ x 4 in. and bottom face 5⅛ x 5⅜ in. Base has adjustment screw and ground ways and has gage points for positioning work with size blocks or calipers. It also has straddle clamp with adjustable set screws to tighten work against bottom face of angle plate. Various accessories are available.—**AVIATION, Jan., '46.**

Parts Cleaning Machine.....79

Portable parts cleaning machine, which agitates cleaning fluid by air, is announced by **Park Chemical Co.**, Detroit. Requiring no heat, this machine, designed for use in repair shops, combines two systems of cleaning in one unit. Large parts are placed in tank, while small parts are placed in basket, soaked in solution for few minutes, and swished by hand. Basket is then placed on attached drain shelf and parts are blown

Statement of Position~

Until the present tight steel situation is eased, there will be an unbalanced condition in all steel stocks.
There are three principal reasons for this:

1. **Labor and coal shortages are currently lowering steel production.**
2. **Every industry is anxious to get on with reconversion and peacetime production.**
3. **There is a tremendous backlog of maintenance and repair requirements.**

Ryerson stocks, largest in the nation, reflect current conditions. And because of the great load, it is not always possible to supply the desired steel or deliver available steel as quickly as usual. But we are doing everything we can to satisfy every customer's requirements.

When a certain kind or size of steel is not immediately available, every effort is made to suggest satisfactory alternates which buyers may use with confidence.

Ryerson's 103 years of experience in maintaining large and complete stocks and working closely with all industries, makes the recommendations of Ryerson metallurgists and engineers particularly practical and helpful.

We thank our customers for their courtesy and patience, for the confidence they have placed in our judgment when alternates for wanted steels have had to be offered, and for understanding our position.

Ryerson will continue to serve you to the best of its ability from its eleven strategically located plants. Stocks will be brought to normal as quickly as possible. This means that Ryerson will be among the first to have more complete stocks of present scarce steels—that Ryerson will continue to be the largest single source for steel in the country.

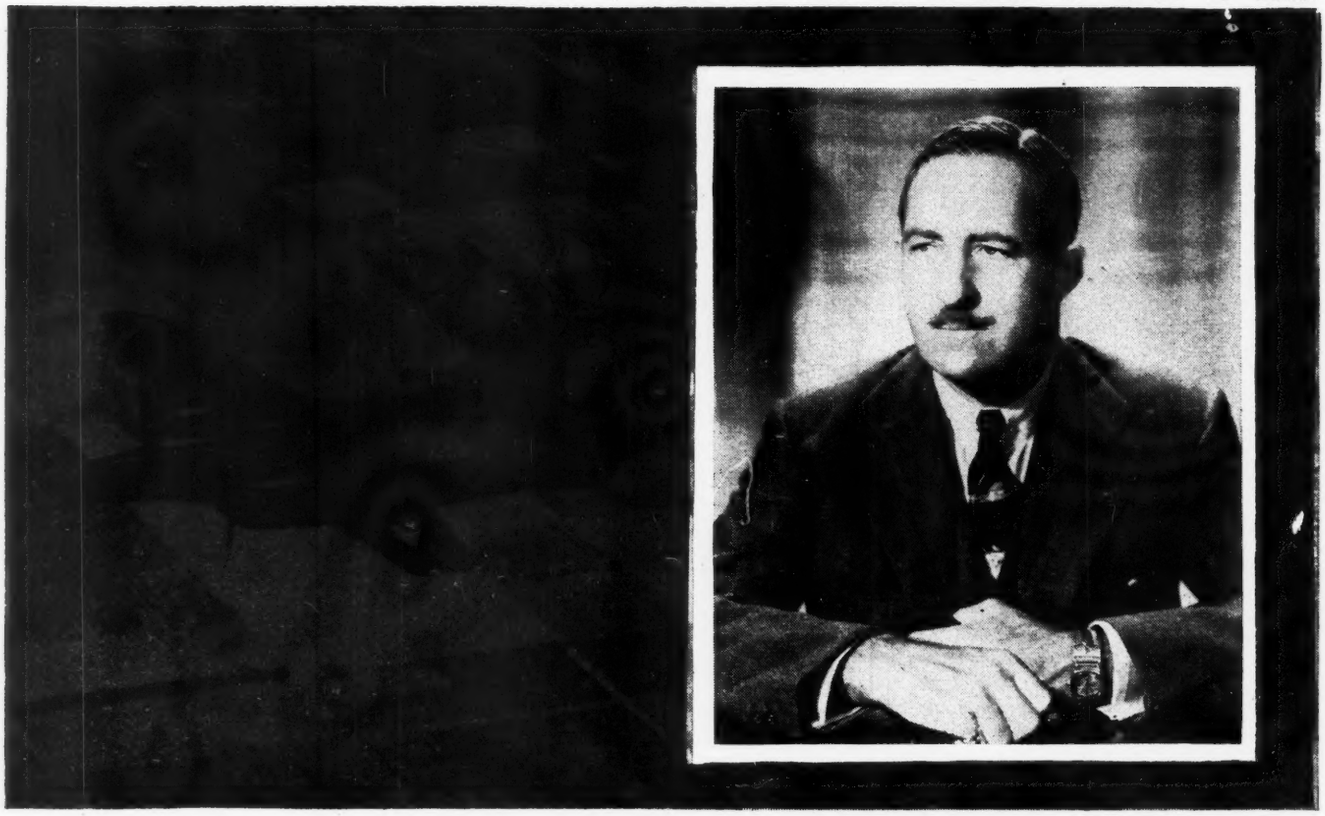
Ernest V. Graff

President
Joseph T. Ryerson & Son, Inc.

RYERSON STEEL

Steel-Service Plants at: **Chicago, Milwaukee, Detroit, St. Louis, Cincinnati, Cleveland, Pittsburgh, Philadelphia, Buffalo, New York, Boston**

This is the thirtieth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME



"Now Aviation must guard our hard-won peace"

says LAMOTTE T. COHÛ, Chairman of the Board and General Manager, Northrop Aircraft, Inc.

"THE ATOM BOMB *could be the missile of a little David or a giant Goliath against us. Our shield against this missile must be airpower. Another World War (if it comes) will not be a race of manpower but a race of technicians and scientists. And we shall find that the bigness and richness and geographical isolation of America are no longer enough. Today there is no spot on the globe which cannot be reached by our new 10,000-mile bombers.*

"To guard our peace we must have the best planes and aerial weapons we can devise. We ought to maintain at all times: (1) a production nucleus with the know-how to produce new planes in quantities; (2) the trained men to fly these planes; (3) research in experimental and production design. Moreover, we must continue to keep our scientists, engineers and aerodynamicists—the best in the world —at work on these problems.

"Only thus can America continue to live in safety and peace and with dignity."

• • •

The kind of people you are addressing, Mr. Cohû (the thinking, progressive nucleus of our nation), are the kind who will be first to buy aviation's new postwar services, too. They are America's "test pilot" market—men and women like the more than a million families who read TIME.

Nearly 40,000 TIME families have already *owned and flown their own airplanes (more than 500,000 say they hope to some day); and more than 300,000 had a member of the family in the Air Corps during the war.*

In peace or war, wherever America flies, TIME flies too. Wrote an AAF general: "I have seen battered copies of TIME being read by groups of combat crews as they were awaiting the time to take off, or 'sweating' their formations back."

Writes the Assistant to the President of a leading airline: "TIME is about the most popular publication carried aboard our ships."

No wonder airline travelers vote TIME their favorite magazine by margins up to 7 to 1 over any other magazine.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of

AVIATION'S SILENT PARTNERS

TIME

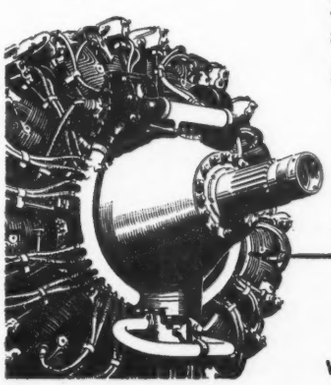
THE READERS OF TIME

B-29 SETS DISTANCE RECORD
CONSTELLATION IS CHOSEN BY EIGHT MAJOR AIRLINES
MARS HAULS 6-TON CARGO IN RECORD HOP TO NATAL
U. S. SPANNED IN 6 HOU
Stratocruiser Sets Transport Record
CONSTELLATION FLIE TO PARIS IN 12:57 HOUR

The power behind the HEADLINES

Look at the records for speed, range, load and fleet efficiency. One engine dominates, one engine makes possible the headlines. One engine has the sheer power, low weight and low fuel consumption to make possible these headlines. It is the Wright Cyclone 18.

Many of the headlines tell of records with military planes—such as the Boeing B-29, Martin Mars, Consolidated B-32 or Boeing C-97. But now that the Cyclone 18 is fully available for commercial use in Lockheed Constellations and other transports, its power will make new records which will be reflected directly in earnings.

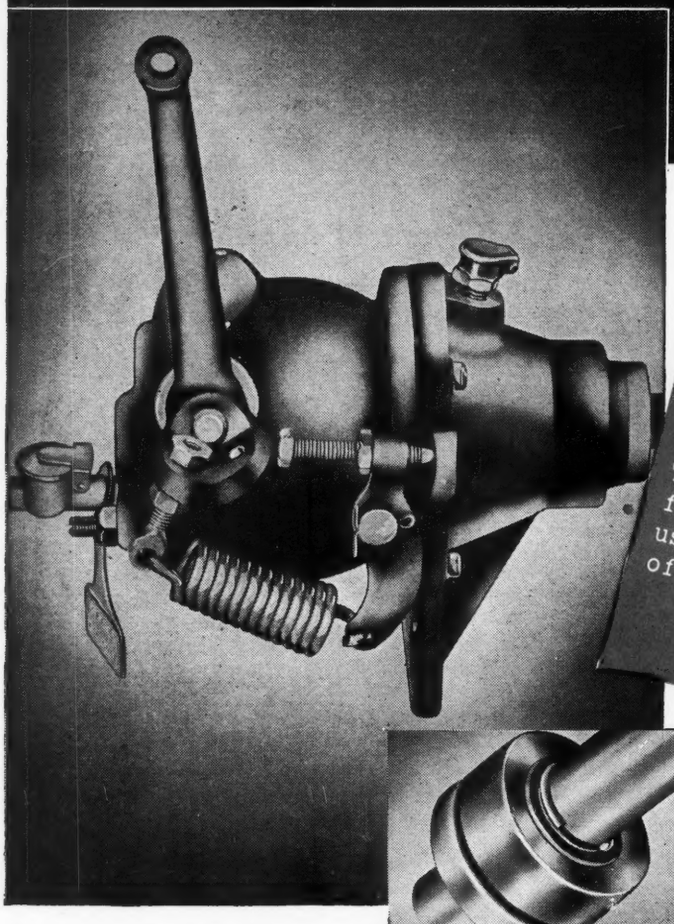


WRIGHT Aircraft Engines

AIR POWER FOR A WORLD AT PEACE

Wright Aeronautical Corporation, Paterson, New Jersey, U.S.A. • A Division of Curtiss-Wright

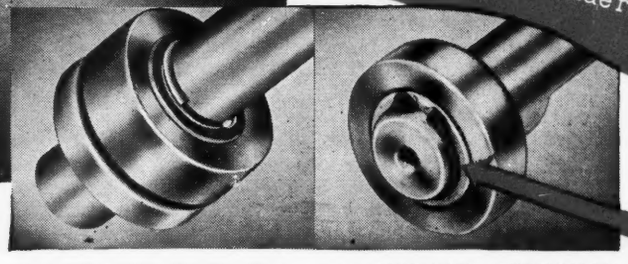
5 REASONS WHY PIERCE GOVERNOR SPECIFIES WALDES TRUARC RETAINING RINGS



THE PIERCE UNIVERSAL GOVERNOR used on most industrial applications of automotive motors.

"Waldes Truarc Retaining Rings on our precision flyball governors had five distinct advantages over wire snap rings previously used:
1. speedier assembly and disassembly—
2. elimination of injury to shafts when installing and removing—3. greater thrust power—4. narrower groove—
5. greatly reduced production costs. Truarc rings are completely satisfactory, and we plan to extend their use to other models that were out of production during the war."

Signed: Pierce Governor Co.
Anderson, Ind.

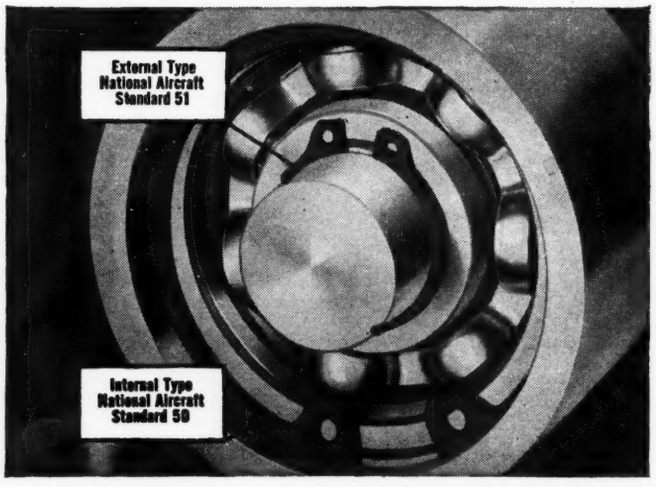


1 BEFORE TRUARC
—Bearings on rocker arm were pressed against shoulders at the bottom of the cast iron housing. Wire snap rings were required, adjacent to inside face of bearings to position the shaft and keep it from moving sideways.

2 AFTER TRUARC
—It was possible to slip-fit the bearings. Truarc Retaining Rings have greatly simplified the design by performing the dual function of *positioning the shaft* and *holding the entire assembly* securely in place.

U. S. PAT. RE—18,144

Waldes Truarc Retaining Rings have increased the efficiency and simplified design of countless machinery products by saving weight, space, cost and man hours. For holding and positioning machine parts, they have definite advantages over nuts, shoulders, collars and pins. They can be put on and taken off time and again—and still retain the perfect circularity which gives them their unfailing grip. Make your own tests. We'll gladly furnish samples and complete data. Write Dept. E-1.



WALDES TRUARC TRADE MARK **RETAINING RINGS**

ARMY E NAVY

THE STANDARD OF QUALITY WALDES

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

CANADIAN REPRESENTATIVE: FRENCO PROGRESS CORP., LTD., 72-74 STAFFORD STREET, TORONTO

dry with air gun and rinsed with water or petroleum spirits. "Tank-Solv," compounded for use in this machine, is stated to be non-evaporating and also re-usable.—**AVIATION, Jan., '46.**

Keyless Chuck 80

Designed to hold drill without tightening with key, new keyless chuck is manufactured by **Turner Brothers,** Ferndale, Mich. Self-energizing chuck tightens itself by action of drill and hardened steel roller-jaws grip drill without scoring. Chuck is also self-centering. Drill capacities now available are 1/32 to 1/16 in., 1/16 to ⅛ in., ⅛ to ¼ in., and ¼ to ½ in.—**AVIATION, Jan., '46.**

Shop Equipment & Materials

Materials Handling 81

"Service Leveler," unit manufactured by **Service Caster & Truck Div., Domestic Industries,** Albion, Mich., is intended to solve such materials handling problems as raising goods from floor level to loading platform, from shipping floor to truck, and

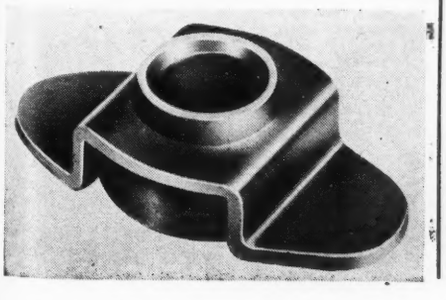
lowering of raw materials from car to floor, as well as performing many other tasks. Mechanism stops platform automatically at top height and floor level, while intermediate stops are controlled manually.—**AVIATION, Jan., '46.**

Plastic Insulated Wire.....82

Enhanced resistance to high temperature is reported with thermoplastic insulated wire produced by **William Brand & Co.,** New York City, and resistance to effects of oils, organic solvents, acids, alkalies, sunlight, ozone, and oxidation are stated to be total. Wire in gages from 24 to 30 is available.—**AVIATION, Jan., '46.**

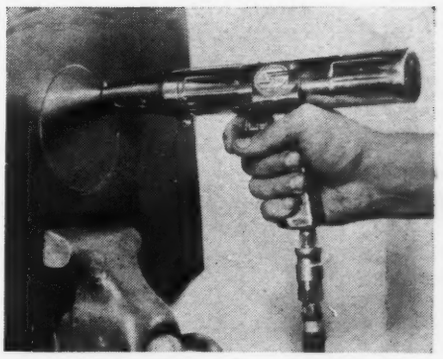
Anchor Bushings 83

Reported to reduce time and cost between drilling and assembly of units in sheet metal structures, anchor bushing method of drill template making is stated by maker, **Hi-Shear Rivet Tool Co.,** Hermosa Beach, Calif., to be highly accurate means of lightweight tooling. Anchor bushings are comprised of hardened steel bushing pressed into low-carbon steel anchor or strap which may be accurately located on, and spotwelded to, thin body steel templates with complete flexibility to hole pattern required. Since body steel templates are readily formed to any desired contour, with hole pattern then laid out and anchor bushings attached, resultant drill template may be applied directly to work and holes drilled accurately on assembly while retaining interchangeability of parts. Elaborate lofting is stated to be eliminated.—**AVIATION, Jan., '46.**



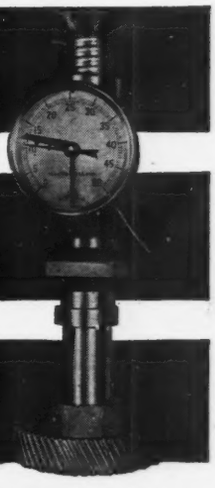
Pneumatic Saw 84

To enable working in cramped quarters or from difficult positions, new "Air-Speed" saw and filing tool, made by **Air-Speed Tool Co.,** Los Angeles, has adjustable barrel permitting circular sawing in metals or woods, as well as dead end keyhole or



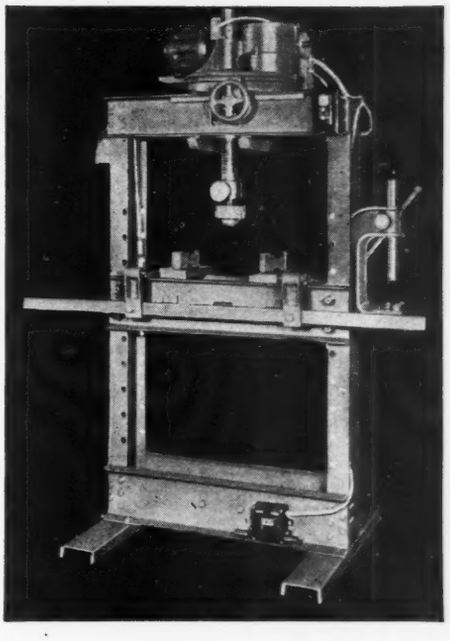
scroll work. Weighing 3½ lb., saw operates with approx. 85 lb. air pressure at tool. —**AVIATION, Jan., '46.**

even the Inexperienced are SKILLFUL with AUTOMATIC PRESSURE CONTROL



PRESSUREMATIC POWER PRESSES

You may select the exact ram travel, speed, and power you need. Ram speed varies from 3" to 12½" per minute; standard ram travel is 9¼", but a 14" travel is available; model illustrated can develop 60 tons pressure in 4 seconds! The Pressurematic is the press for bending, straightening, assembling, disassembling, press-fits, and is ideal for die try-outs. Many exclusive features. Write for details.



- *Automatic Pressure Control*
- *Moveable Ram Head*
- *Adjustable Bolsters*
- *Foot Pedal Switches*

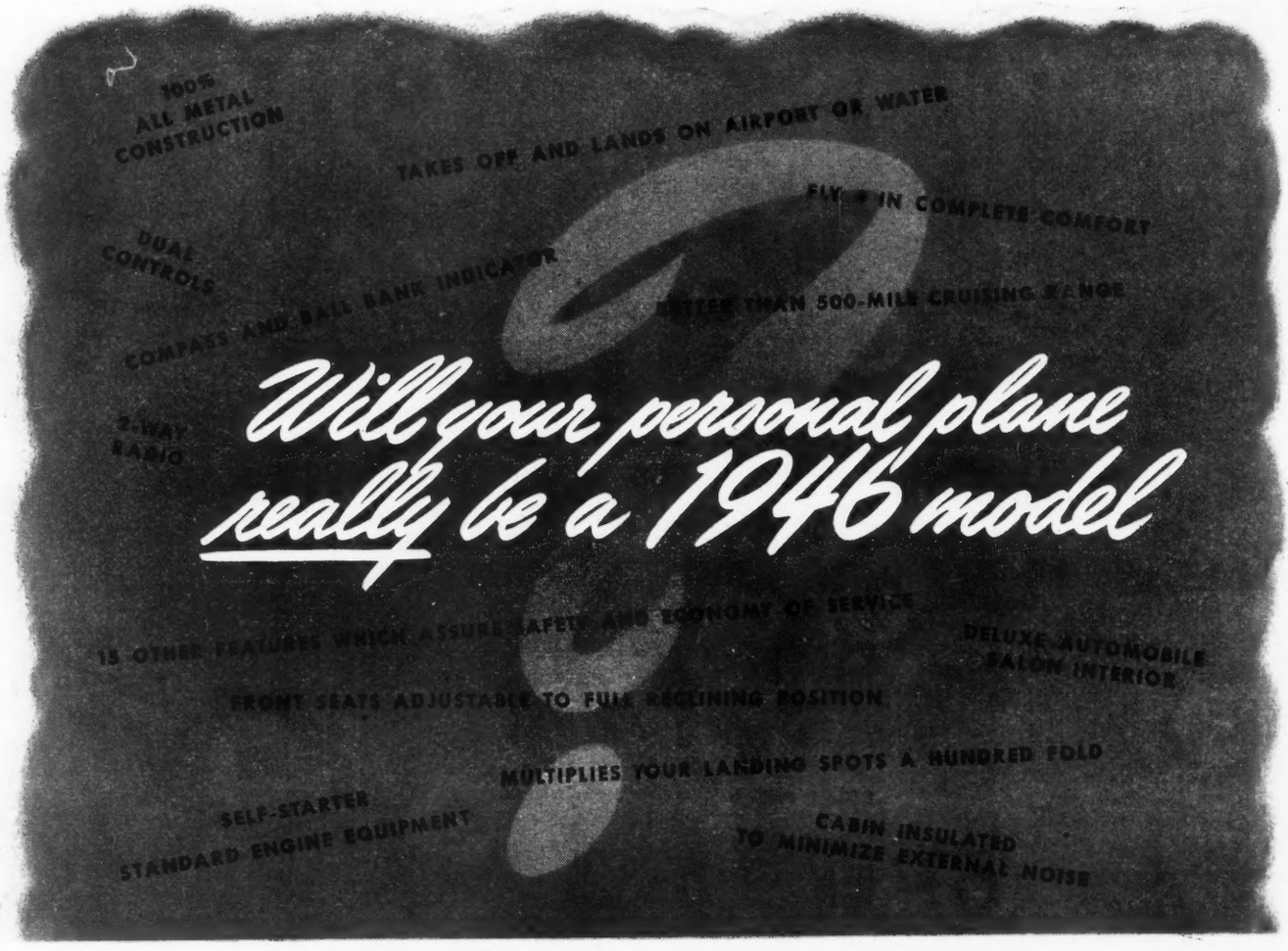
- ELECTRIC & HYDRAULIC MODELS
- 20 TO 60 TON CAPACITY
- CEILING-PRICED*
- GOOD DELIVERY

WRITE FOR THE WHOLE STORY

LEMPCO

5497 DUNHAM ROAD • BEDFORD, O.

** If you order at once*


100% ALL METAL CONSTRUCTION
TAKES OFF AND LANDS ON AIRPORT OR WATER
FLY IN COMPLETE COMFORT
DUAL CONTROLS
COMPASS AND BALL BANK INDICATOR
BETTER THAN 500-MILE CRUISING RANGE
2-WAY RADIO
Will your personal plane really be a 1946 model
18 OTHER FEATURES WHICH ASSURE SAFETY AND ECONOMY OF SERVICE
DELUXE AUTOMOBILE SALON INTERIOR
FRONT SEATS ADJUSTABLE TO FULL RECLINING POSITION
MULTIPLIES YOUR LANDING SPOTS A HUNDRED FOLD
SELF-STARTER STANDARD ENGINE EQUIPMENT
CABIN INSULATED TO MINIMIZE EXTERNAL NOISE

Discriminating buyers will instantly recognize the Seabee 4-place all-metal Amphibian with its revolutionary engineering, as solely a product of progress . . . ¶ *Conceived to measure up to the rapidly advancing needs of the postwar personal plane owner . . . it will be ready for delivery early in 1946 . . .* ¶ *Designed by the same engineering talent which developed the famous Thunderbolt, the Seabee is built to exacting standards that emphasize the inherent rugged qualities which characterize all Republic-built products . . .* ¶ *The broad experience in building aircraft to war's vital needs above all else qualifies Republic to build a comparable product for peace-time use . . . and at a truly modest price . . . $3995. Flyaway Factory.*

☆ ☆ ☆

There's a Blue Ribbon Seabee dealer near you, who'll be glad to give specifications. For further information address Personal Plane Division, Republic Aviation Corp., Farmingdale, L. I., N. Y.

Seabee

A PRODUCT OF **REPUBLIC AVIATION**

Makers of the Mighty Thunderbolt

ESTABLISH YOUR DELIVERY PRIORITY NOW

—the Seabee is well worth waiting for!

ANNOUNCEMENTS—

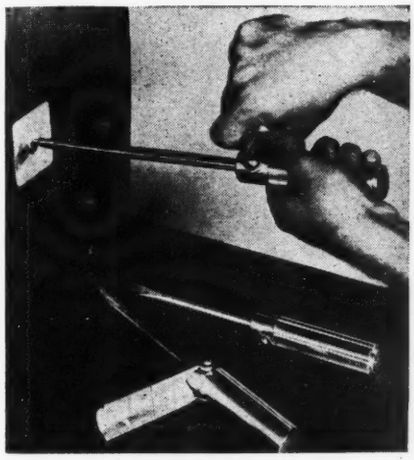
of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION
330 W. 42d St., New York City 18

New Screw Driver 85

"Tuffy" is new screw driver with power arm for giving extra power when needed. Latter folds back into handle. Designed by



Swallow Airplane Co., Wichita, Kan., tool is made with 5 x ¼, 6 x 5/16, and 8 x ⅜ in. blades.—AVIATION, Jan., '46.

Inspection Magnifier 86

Ray Control Co., Pasadena, Calif., announces "Multi-Scale Monocular," designed to measure and compare small objects with aid of corrected six-power optical system and six selectable scales, all of which are incorporated in instrument. Optical arrangement projects scale selected in plane of object to be observed, without scale itself being in contact with surface under observation, making this instrument useful in examination of abrasive surfaces. Scale desired for a particular measurement can be brought into field of view by turning outer rim of eye cap. Circular field of view of 1 in. dia. is automatically in focus when instrument stands on its base. Scales appear in field as illuminated markings, superimposed upon surfaced under examination. Instrument is 2½ in. high, of 2¼ in. dia., and weighs 7 oz.—AVIATION, Jan., '46.

Flexible Tubing 87

Described as non-collapsible under plus or minus pressures, and retractable to about one-eighth its extended length, new type flexible tubing for portable or semi-permanent ventilation, or any handling of air, gases, or light solids, has been developed by **Warner Bros. Co., Spiratube Div.**, Bridgeport, Conn. Inside surface is free from wire ridges. Standard "Spiratube" is made of long-fiber duck, having bursting strength of 170 psi. Fabric, which is fire-resistant, is covered with thermoplastic. It can be made to specifications in other fabrics.—AVIATION, Jan., '46.

New Fastener 88

First drawing the work together in equivalent of bolting-up operation, after which it is rigidly and permanently locked in placed like a rivet. "Lockbolt," new type fastener, is announced by **Huck Mfg. Co.**, Detroit. Device consists of pin, having head of any desired shape, locking grooves, breakneck groove, pull grooves which fit

Censored!

BE THANKFUL YOU CAN'T READ SHORTHAND, BROTHER!

So your letters come back all balled up! Sentences transposed, new words substituted, erasures in evidence, margins mangled, and you heap the blame on your steno's head.

Don't do it.

It may not be all her fault. First take a look at the chair she's forced to use. If it cramps her muscles, curves her spine and frays her nerves, *replace it* with a CRAMER POSTURE CHAIR.

Accuracy isn't accidental. Often it's the result of scientific seating comfort such as CRAMER POSTURE CHAIRS provide.

MODEL 2151

Finger-Tip Height Adjustment.

Tubular Steel. Cushioned Comfort.

Available with or without removable covers.

2151-D

Cramer Posture

CHAIR COMPANY

CREATORS OF AIR FLOW COMFORT IN EXECUTIVE, SECRETARIAL, GENERAL OFFICE & FACTORY CHAIRS

1205 CHARLOTTE STREET • KANSAS CITY 6, MO.

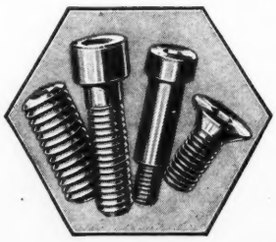
ALLEN TRU-GROUND

Dowel Pins

All you know to be symbolized by the ALLEN trade mark, — in metallurgy, precision workmanship, product-DEPENDABILITY, — all this applies to *TRU-GROUND* Dowel Pin *in these particulars:*

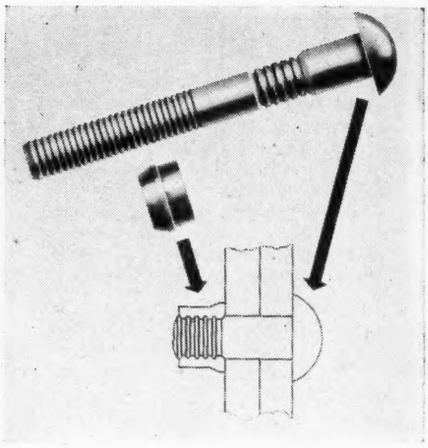
We make them of special-analysis ALLENOY steel, heat-treated to an extremely hard surface, with a core of the *right* hardness to prevent "mushrooming" when driven into a tight hole. We grind them to a limit of .0002" over basic size, with an allowable tolerance of plus or minus .0001". Surfaces are finely polished; subsequently treated with a rust-preventive.

Their tensile strength is 240,000 to 250,000 psi. By their strength and accuracy they dependably *uphold* precision standards in tool, die and machine assemblies.



Ask your local Industrial Distributor for samples and dimensional data, — the same Allen Distributor who serves your interests with the most dependable supply-items in all lines. He carries also a complete line of Allen Hex Socket Screws shown at right.

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.



jaws of driving gun, and a locking collar. After pin is inserted in work, collar is slipped on and gun applied. Hand-operated and pneumatic guns are available. As gun pulls pin, reaction is taken by collar against a swaging anvil in nose of gun. Pull on pin is then increased until anvil is forced out over collar, squeezing collar into locking grooves of pin to form lock. Pin is then automatically broken off at breakneck groove.—**AVIATION, Jan., '46.**

Hard Tachometer 89

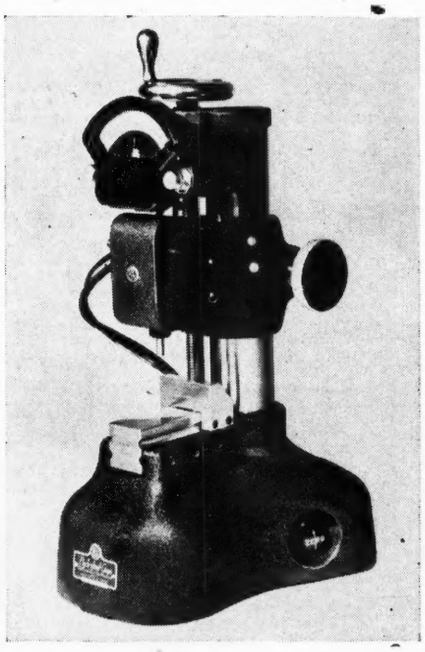
Operating on centrifugal principle and having five speed ranges, hard tachometers made by **George Scherr Co.**, New York City, are designed for reading speed of any revolving equipment. Four models provide ranges 30 to 12,000 rpm., 45 to 18,000 rpm., 60 to 24,000 rpm., and 120 to 48,000 rpm. Each dial is individually calibrated for each instrument. Maker states measurements may be as close as 1 rpm. Attachments give readings in ft. per min.—**AVIATION, Jan., '46.**

Deep Drawing Compound.....90

"Superdraw" is new chemically stable deep drawing compound reported to maintain its inherent physical properties during repeated use. Electrical properties of molecules at interface, between lubricant and metal surfaces, remain constant during drawing operation. Chemically inert, compound leaves no heavy scale nor does it stain alloys. Material may be applied by hand, brush, spray, roller, dipping, or pouring, and may be extended by diluting with warm water. Maker is **Northwest Chemical Co.**, Detroit.—**AVIATION, Jan., '46.**

External Comparator 91

Described as quick and accurate in inspecting parts for size, new "Electrolimit"



First in the field... Standard for industry

Federal SELENIUM RECTIFIERS For DEPENDABLE AC to DC Power Conversion

Federal Selenium Rectifiers, the first to be introduced in the United States, are recognized throughout industry as the standard for dependable power conversion.

Made in a wide range of sizes and outputs . . . combining extreme efficiency with low first cost and phenomenal savings in space, weight and mounting requirements . . . Federal Selenium Rectifiers are engineered and built to meet exacting demands wherever DC current is needed from an AC source. These rectifiers have proved their superiority in communications, aviation, cathodic protection and in numerous other fields.

- Rugged . . . Compact
- No Moving Parts
- Low Cost . . . Long Life
- High Efficiency
- Zero Maintenance
- Wide Temperature Range

Capitalize on Federal's design and engineering leadership . . . solve your power conversion problems with Federal's Selenium Rectifiers . . . "First in the Field and Standard for Industry." Write for data now.

ARMY E NAVY M

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

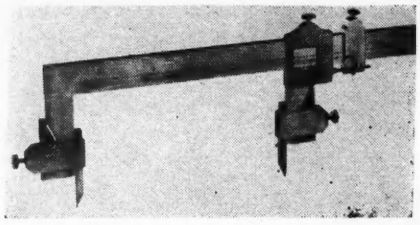
comparator, made by **Pratt & Whitney Div., Niles-Bement-Pond Co.**, West Hartford, Conn., is combination of electric contact unit and electrolimit head with small neon tube undersize-and-oversize lights positioned at sides of meter. Actual size reading is obtained from indicating meter when desired.—**AVIATION, Jan., '46.**

Electronic Bore Gage.....92

Comprising a projection rod mounted on stabilized frame and containing a delicate, flexible point, new electronic bore gage is for use in measuring cylindrical interiors. It is inserted into bore to contact-check all interior surfaces, and results are transmitted to precision indicator. Maker is **Chrome Gauge Corp.**, Philadelphia.—**AVIATION, Jan., '46.**

Caliper Radii Attachment.....93

Described as saving time and increasing accuracy in layout work, checking, and



measuring, radii attachment for vernier calipers, made by **Modern Machine Tool Co.**, Detroit, may be set to any desired dimension. Also, by raising one scriber and lowering other, tool may be used in hard-to-get-at places.—**AVIATION, Jan., '46.**

Articulated Fork Truck.....94

Designed to require less aisle space and less clearance on turns, Type AIMH articulated fork truck made by **Baker Industrial Truck Div., Baker-Raulang Co.**, Cleveland, has cap. of 4,000 lb. By "articulating" frame in steering, load may be lined up in position without lining up truck itself, thus requiring about 3 ft. less aisle space, which saving is contributed to available storage space.—**AVIATION, Jan., '46.**

Carbon Remover, Cleaner.....95

Kelite Products, Los Angeles, announces two new products—"Parts Cleaner," carbon remover and parts cleaner, and "Alu-Clean," for removal of air film and other operational soil from aluminum. "Parts Cleaner" is stated to have no flash point and to be safe on all metals. "Alu-Clean" is semi-liquid applied with wet mit or cloth —rubbed on and allowed to dry, then rubbed off.—**AVIATION, Jan., '46.**

Expansion Reamer 96

New design dual-expansion reamer, made by **Lempco Products**, Bedford, Ohio, fea-

tures one-piece body from driving end to lower lock nut, plus increased rigidity to insure accuracy.—**AVIATION, Jan., '46.**

New Explosive Rivet.....97

Retaining basic features of previous types used extensively in aircraft industry, new explosive rivet made by **E. I. du Pont de Nemours & Co.**, Wilmington, Del., is stated to eliminate necessity for close tolerance drilling and to accommodate wide range of metal thicknesses. Rivets are now available in 1/8, 5/32, and 3/16 in. dia., made of aluminum alloys, brass, copper, mild steel, and also Monel metal.—**AVIATION, Jan., '46.**

S-O-S Fire Guard

vaporizing liquid extinguisher (above) is Underwriters' approved for use on electrical, chemical, gasoline, and paint fires. One quart or 1½ qt. size.

WOULD you use a bus for bricks? A panel truck for gravel? Not likely. Every vehicle has its own job.

And every fire extinguisher also has its own job. Gasoline and oil fires, for example, call for an entirely different extinguisher than textile and rubbish fires.

Stationed near you is a trained Fire Protectioneer able to advise you on the correct equipment for your every fire hazard. Backing him is this 40-year-old concern, manufacturing a *complete line* of Underwriters' approved fire extinguishers. There is no charge for this service.

Call your distributor or write direct.

IF IT'S GENERAL IT'S DEPENDABLE

THE GENERAL DETROIT CORP.

2270 E. JEFFERSON AVE., DETROIT 7, MICH.

Distributors in principal cities

CHICAGO DALLAS NEW YORK

West Coast Affiliate: The General Pacific Corp.

Seattle • LOS ANGELES • San Francisco

Electrical Appliances

Megohm Meter 98

Described as offering exceptional protection against atmospheric conditions where precise testing is required, with portability and range from 400,000 ohms to 100,000 megohms in five ranges on single-scale 4-in. meter, Model 1500 megohm meter, made by **Communication Measurements Laboratory**, New York City, weighs 8 lb. Among wide range of applications are measurements of leakage resistance of insulation, condensers, coaxial cables, wiring harness, and also motor and transformer windings. Single zero reset adjustment is provided for all ranges, and drift after initial warm-up period is stated to be substantially zero. Line voltage is 115v. at 60 cycles.—**AVIATION, Jan., '46.**

Voltmeter and Amplifier.....99

Suitable for measuring amplifier gain, network response, and output level at audio and radio frequencies, new combination of vacuum tube voltmeter Model 451 with amplifier Model 101 has been produced by **Reiner Electronics Co.**, New York City. Its 25 millivolts a.c. on lowest range, and 1,000v. on highest range, its 10 cps. to 700 megacycles frequency range, and 7 microfarads input cap. gives unit high sensitivity, voltage range, and capacity. Features incorporated are: Single linear scale for all voltage and current scales, single zero adjustments for all a.c. and d.c. ranges, voltage regulated supply, large overvoltage cap., and fuse located on panel of meter.—**AVIATION, Jan., '45.**

Lightweight Geared Motor.....100

First of group of new lightweight continuous-duty geared electric motors is announced by **Jack & Heintz**, Cleveland. Model JH-13100, designed for 28v. d.c. systems, is rated for continuous duty at 3 hp. with speed of 3,800 rpm. at splined output shaft. Developed to operate at 40,000 ft.,

with the new RCA Aircraft Transmitter AVT-49

DESIGNED for remote voice or key operation on four crystal-controlled channels—from 2.85 to 13 mc.—this compact transmitter weighs only 34.5 pounds and has a power output of 50 watts.

The transmitter unit is completely self-contained, eliminating the need for external power supplies or vibrator packs. It's easy to tune—a single coil is used for both tuning and loading—and it's easy on the battery, with low relay and standby current consumption.

The band-change mechanism is of the dependable ratchet type; there's no motor to replace—no motor brushes to wear out. Fuses have been eliminated through the use of thermal circuit-breakers. Latest type shockmount with center-of-gravity suspension sets the mechanical resonance below 10 cps. Life-tested for better than 10 g. vibration, the AVT-49 Transmitter is built to meet CAA requirements for scheduled airline operation.

For a transmitter that's heavy on performance but light in weight—get the story on the new AVT-49 now. Send the coupon *today.*

Aviation Section,
Radio Corporation of America,
Engineering Products Division,
Camden, N. J.

Please send me details and specifications on the new RCA AVT-49 Aircraft Transmitter.

Name_____

Company_____

Street_____

City_____ State_____

15-A

AVIATION SECTION

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION, CAMDEN, N. J.

A SAVING AT EVERY TURN

DARNELL CASTERS

Darnell Casters and E-Z-Roll Wheels reduce floor wear to a minimum, increase employe efficiency and lengthen the life of equipment.

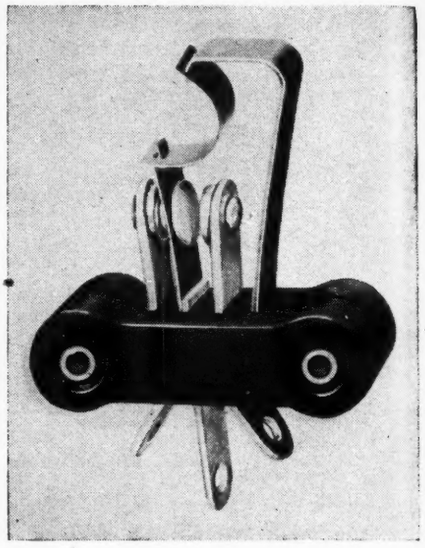
DARNELL CORP. LTD. LONG BEACH 4, CALIFORNIA

60 WALKER ST., NEW YORK 13, N.Y.
36 N. CLINTON, CHICAGO 6, ILL.

weight is 19½ lb., and unit occupies cylindrical space approx. 6 x 10½ in. Connector is AN type, drive and mounting flange is standard AND 10001-D2, and cradle support optionally employs same mounting belt hole spacing.—**AVIATION, Jan., '46.**

Snap Switch 101

Engineered for high compactness for mounting in multiples as well as singly, Model M open blade snap switch developed by **Acro Electric Co.**, Cleveland, measures



approx. 1-13/32 x 1-1/64 x 5/16 in. Standard operating pressure is 6 to 10 oz. Switch is rated at 15 amp., 125v. a.c. and 1/3 hp., 110 a.c.—**AVIATION, Jan., '46.**

New Triode Tube 102

Designed primarily for mobile application, new transmitting (or receiving) triode tube known as "Tuf-20" has been developed by **Taylor Tubes,** Chicago. Featuring "Nonex" glass and a tantalum plate, tube will operate at full ratings up to 250 mc. and at reduced ratings for higher frequencies, maker states. Tube has instant-lighting thoriated filament permitting power conservation during standby periods, yet may be brought quickly up to max. operating temperature. —**AVIATION, Jan., '46.**

Small Generator 103

Lightweight generator capable of supplying up to 1,200w. in continuous duty is available in 500, 600, and 1,200w. cap. at 32 and 120v., 50 deg. F. temperature rise. Weight is 20 to 25 lb. Generator is totally enclosed and glass-insulated, and it is equipped with life-time lubricated ball bearings. It can be supplied as two-bearing or single bearing unit. Integral panel with meters and voltage regulator is available. Maker is **Electrical Engineering & Mfg. Co.,** Los Angeles.—**AVIATION, Jan., '46.**

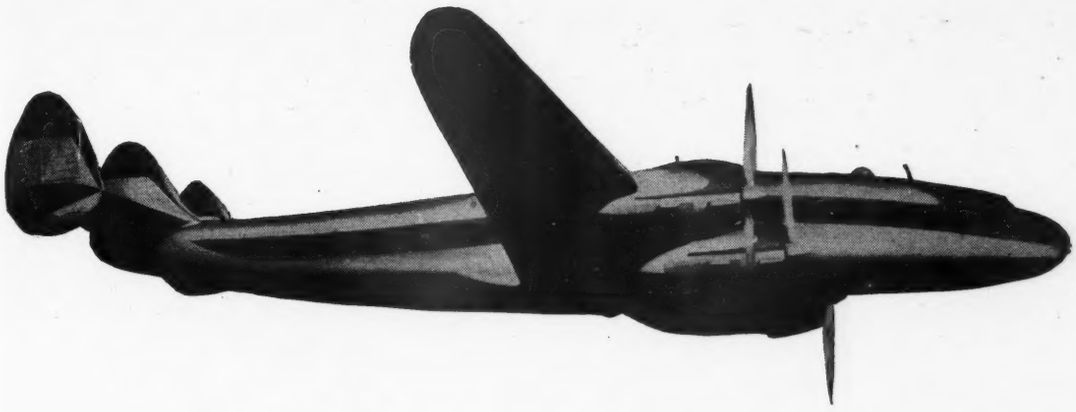
Electric Motor Grease.....104

Westinghouse Electric Corp., Pittsburgh, announces new grease for ball and roller bearing motors for use from 13 to 176 deg. F., at all speeds up to 3,600 rpm., and for horizontal or vertical operation. Packed in 8 oz. nasal type tube, grease is reported highly resistant to oxidation, drying, caking or separation.—**AVIATION, Jan., '46.**

Aircraft Parts & Field Units

Fuel Pump 105

Reported to hold discharge pressures within ¾ psi., plus or minus, of initial setting, new Titan aircraft fuel pump devel-



New World Standard

The claim is proved. Lockheed Constellations will bring new world standards in air transportation to every country on every continent. In regular scheduled service first on these great airlines:

AMERICAN AIRLINES OVERSEAS

EASTERN AIR LINES

FRENCH GOVERNMENT AIRLINES

ROYAL DUTCH AIR LINES (KLM)

NETHERLANDS INDIES AIRLINES (KNILM)

PAN AMERICAN WORLD AIRWAYS

PAN AMERICAN-GRACE AIRWAYS (PANAGRA)

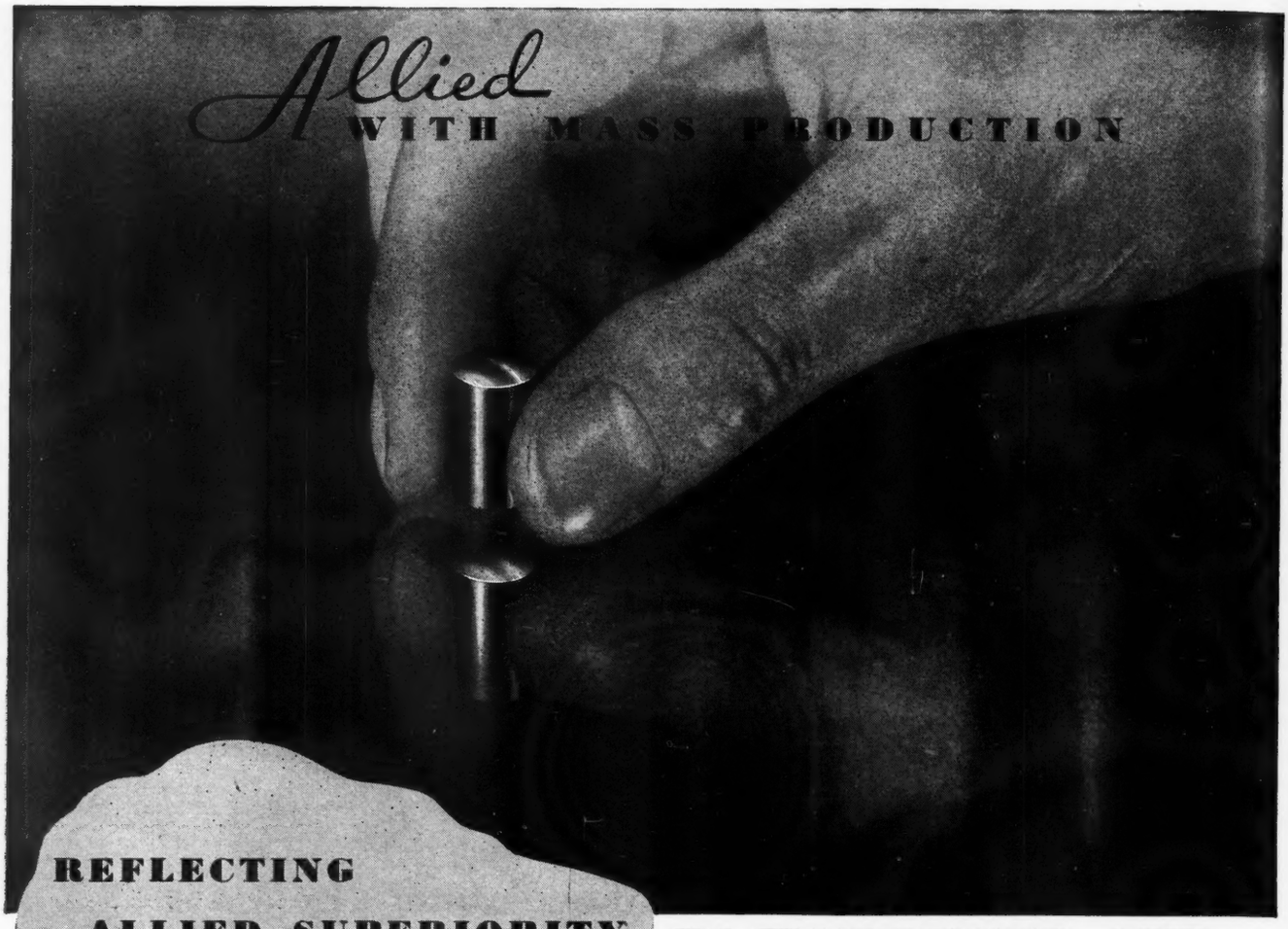
TRANSCONTINENTAL & WESTERN AIR (TWA)

THE NEW AIRLINE STANDARD

Lockheed Constellation

Look to Lockheed for Leadership LOCKHEED *Years Ahead in the Science of Flight*

© 1945, Lockheed Aircraft Corporation, Burbank, California, U.S.A.



REFLECTING ALLIED SUPERIORITY IN HARDENED AND PRECISION GROUND PARTS

THIS valve tappet roller pin is perhaps one of the simplest-appearing parts produced at Allied Products, yet it typifies the production skill and ingenuity of the entire Allied organization.

Special machining methods developed by Allied Products to form the radii on the two ends have made it possible to produce millions of these pins much more rapidly than by operations previously employed. Closer tolerances have been held. Because of lower manufacturing costs, the customer has realized appreciable savings.

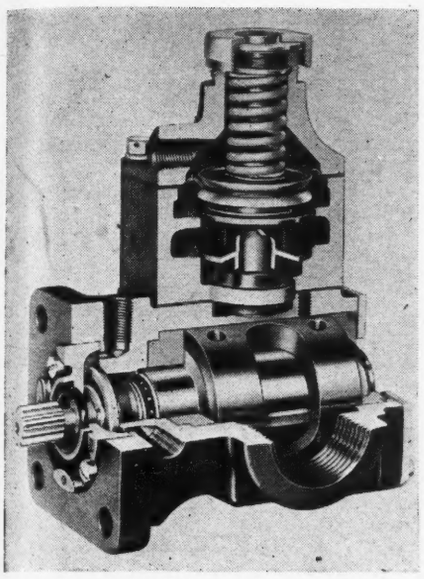
In each of the four large, modern Allied plants new and better methods of manufacture are constantly being developed and put in use. The resulting benefits of faster production, higher quality and lower costs are reflected in parts now being produced for mass production industries. If you are not entirely familiar with our unusual facilities, let us send you our new brochure.

ALLIED PRODUCTS CORPORATION

DEPARTMENT 1-A
4614 LAWTON AVENUE
DETROIT 8, MICHIGAN

PRECISION • EXPERIENCE • DEPENDABILITY
ALLIED CORPORATION PRODUCTS

SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • HARDENED AND PRECISION GROUND PARTS • SHEET METAL DIES FROM THE LARGEST TO THE SMALLEST • JIGS • FIXTURES • STEAM-HEATED PLASTIC MOLDS • SPECIAL PRODUCTION TOOLS • R-B INTERCHANGEABLE PUNCHES AND DIES • DIE MAKERS' SUPPLIES



oped by **Candler-Hill Corp.**, Detroit, incorporates dual valves, working on common guide pin, balancing each other to make possible close pressure regulation. Two models have respective cap. of 830 and 1,600 gal. per hr. at 2,500 rpm. Pressure adjustment is from 5 to 35 psi. Valves function at 65 deg. F. below zero.—**AVIATION, Jan., '46.**

Aircraft Lubrication Charts.....106

Chek-Chart Corp., Chicago, announces 33 lubrication charts covering 111 models of 22 different makes of civilian aircraft. Charts are bound in book form, with four pages of instructions covering accessories and component parts, and with engine oil recommendations for nine makes of aircraft engines. On phantom perspective illustration of plane, arrows identify points to be lubricated, and lubricants and intervals are given.—**AVIATION, Jan., '46.**

Tire Vulcanizer 107

Reported to take guesswork out of hot patching of tires and tubes, automatic "Resistoflex Vulmaster," made by **Resistoflex Corp.**, Belleville, N. J., repairs injuries of any size on aircraft tubes. Feature is small fuse automatically controlling temperatures and shutting off current when flow-point of rubber is reached.—**AVIATION, Jan., '46.**

Your
ASSEMBLY SAVINGS
also
CUT SERVICING TIME

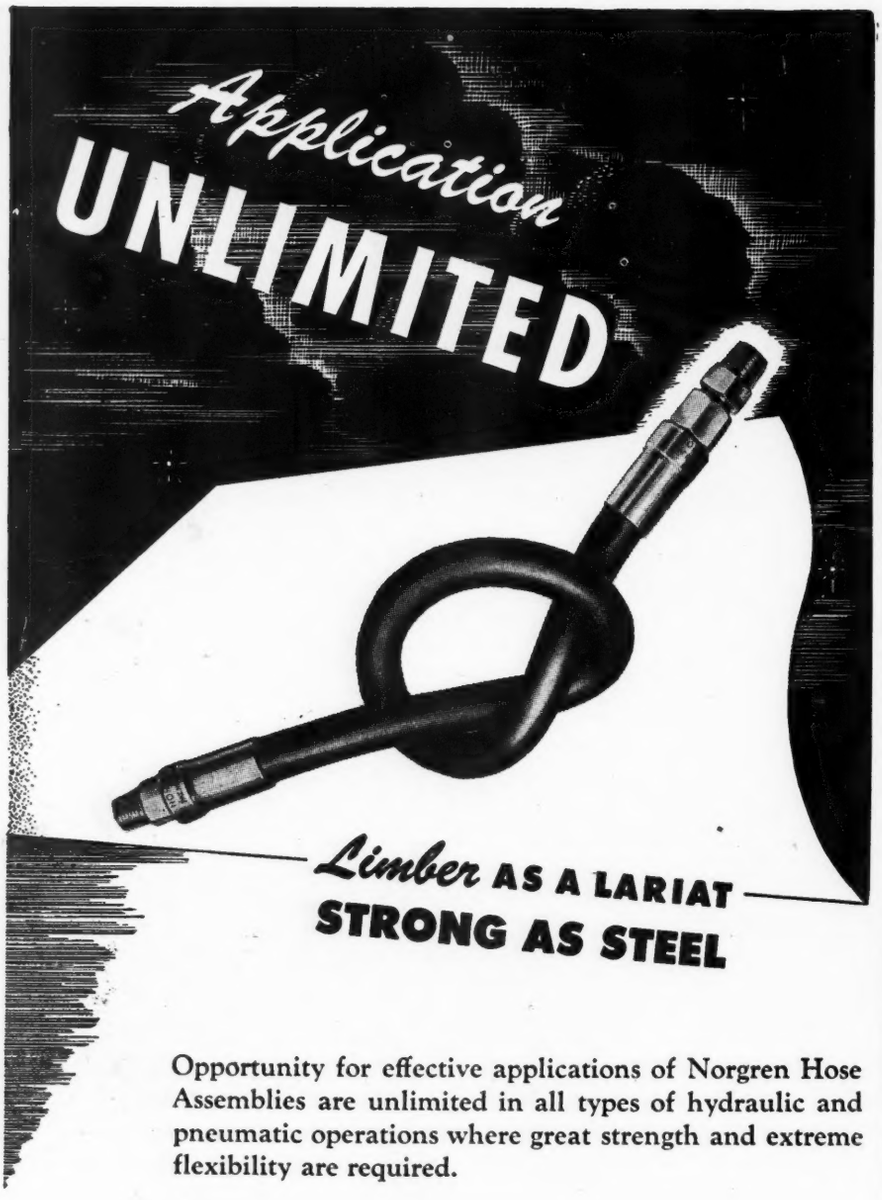
THE HOURS YOU SAVE in factory assembly by simply *peeling* precision laminations for accurate fitting of machine parts will be repeated by your users on every service adjustment. Want performance data and photo chart of applications?

Laminum shims are cut to your specifications, but shim materials for repair are sold through your industrial distributors.

Laminated Shim Company, Incorporated
80 Union Street • Glenbrook, Conn.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

2215



Opportunity for effective applications of Norgren Hose Assemblies are unlimited in all types of hydraulic and pneumatic operations where great strength and extreme flexibility are required.

OUTSTANDING FEATURES:

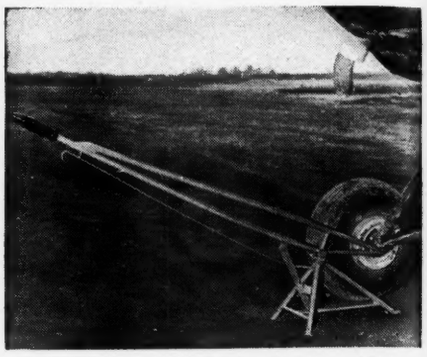
- Oil resistant synthetic rubber hose, reinforced with high tensile steel wire woven into the hose for maximum strength and positive passage even on short bends.
- Impervious to heat, cold, and solvent. Highly resistant to continuous vibration.
- Permanent machined couplings for high pressure and reusable couplings for low pressure.
- Recommended for working temperatures of —40° F. to 250° F.
- Available with I. D. of 1/4" to 1" inclusive, any length.

Write for new Bulletin No. 450. C. A. Norgren Co., 220 Santa Fe Drive, Denver 9, Colorado.

Norgren

Aircraft Jack 108

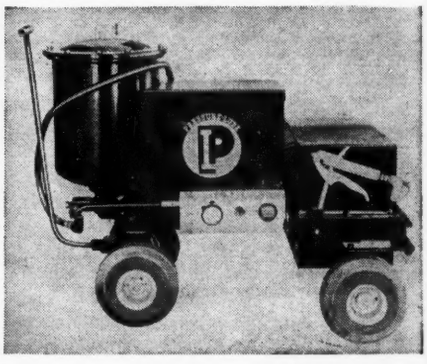
Made of strong, lightweight aircraft tubing, "Quick-Lift" aircraft jack raises wheel with slight push on handle, ratchet



locks it, and trigger pull releases and lowers wheel slowly. For use on soft ground, wood base is available. Maker is **Consolidair, Inc.**, Alliance, Ohio.—**AVIATION, Jan., '46.**

Portable Greasing Unit.....109

Available with battery powered or gasoline driven motor, new, portable greasing unit developed by **Pressurelube, Inc.**, New



York City, delivers up to 12,000 lb. pressure. Device can be supplied with grease gun for every purpose.—**AVIATION, Jan., '46.**

Wanted: Retailers

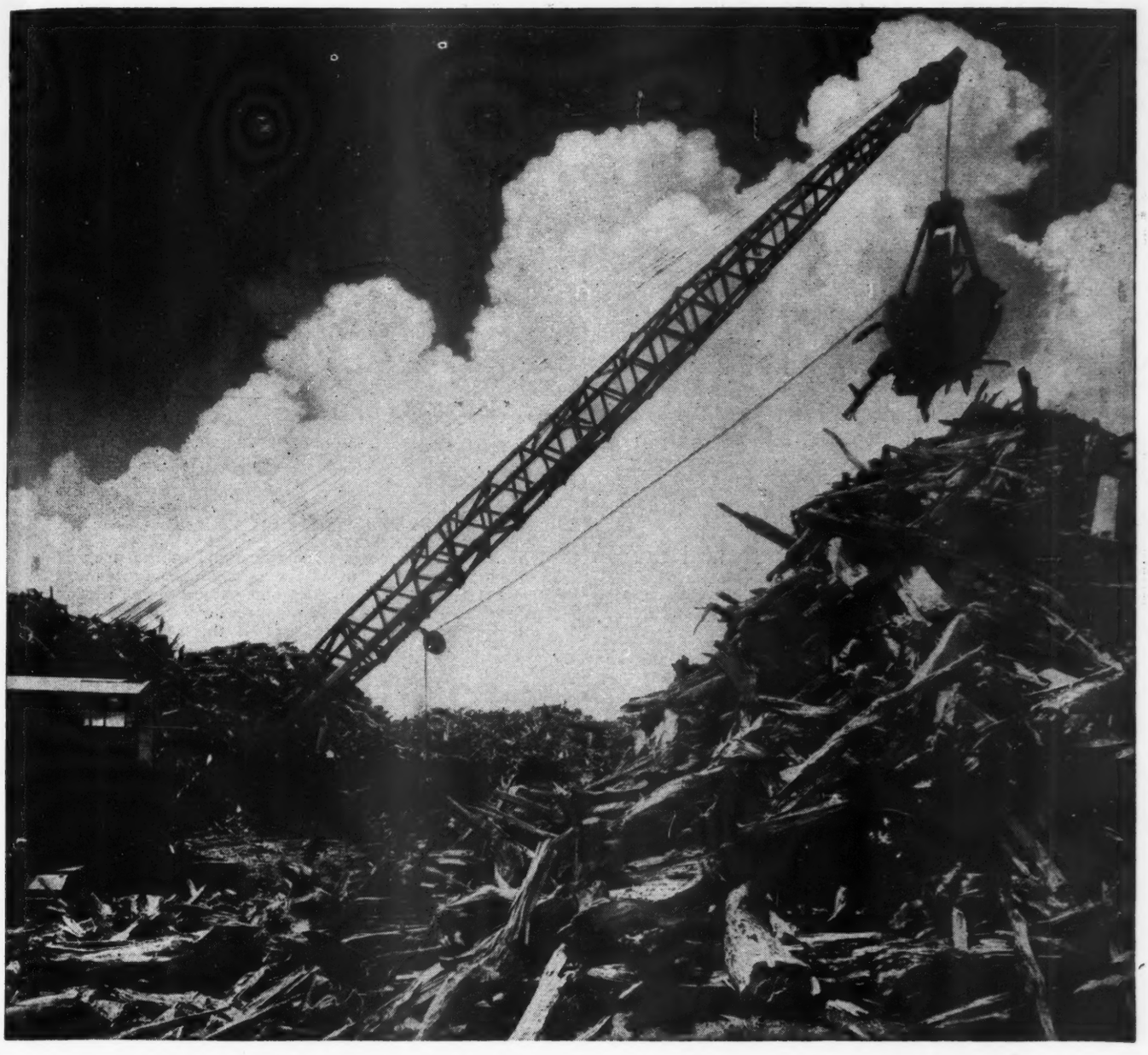
(*Continued from page* 107)

distributor is considered, and it is the retailer who makes the long profit.

It becomes, therefore, increasingly difficult to understand why the big rush of people into the aviation business is a rush toward wholesale franchises rather than retail, either for aircraft or parts and accessories.

It would seem, then, that the principal emphasis needed in this business today should be on the desirability and the potential profits which can be secured through establishment of strong retail sales organizations. One has only to look at the automotive business, the boat business, or any other typical transportation business, to see that, for the most part, the retail operations are by far the most profitable and certainly the simplest to run. It takes time, however, to build a successful retail organization.

With, say, only six to eight months to go, most alert operators throughout



Found in a heap of pine stumps . . . a way to make tires better

SOME sort of soap is used in making all types of synthetic rubber for tires. At first, it was soap derived from animal fats. But out of pine stumps, like those in the picture, came the answer to making better tire synthetic rubber.

That answer is to use soap made from the *rosin* in pine stumps. B. F. Goodrich developed a new synthetic —GRS-10—with this important difference: Tires were made from the new rubber, and tests proved them so far superior that the development became an important military secret.

Tires made from the new rubber give more wear than tires made from ordinary synthetic. They run cooler. The rubber is more flexible, which is important in controlling cracking under heavy loads. Tires keep their strength. Tire life is increased.

Now all the synthetic rubber used in B. F. Goodrich airplane tires is the new GRS-10. That is typical of the B. F. Goodrich policy to make their Airplane Silvertowns always the finest, safest airplane tires on the market. That policy has caused B. F. Goodrich low-pressure Silvertowns to be the favorite of airline and private pilots for years. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

Skyway or Highway

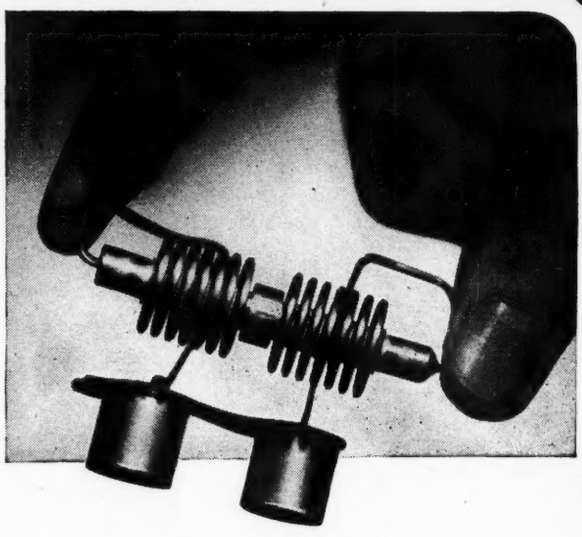
B.F.Goodrich

FIRST IN RUBBER

How one metal made possible

THIS NEW TYPE AIRCRAFT FUEL PRESSURE GAUGE

During the war, a new type fuel pressure gauge had to be developed for military aircraft that climb and dive at great speed and fly at extreme altitudes.



1—THE PRESSURE-SENSITIVE ELEMENT

There are no springs or diaphragms in the pressure-sensitive element of the new gauge. Instead, two metal bellows contract and expand according to variations in fuel and air pressure. Left-hand bellows receives the pressure of the fuel; right-hand bellows is open to the atmosphere.

2—THE ASSEMBLED GAUGE

Here's the completely assembled gauge, with cover removed. Note how the outside end of each bellows is rigidly restrained. All bellows' movements are transmitted to the central spacer, which in turn actuates the sector arm and needle.

Readings are in terms of actual fuel pressure above the existing air pressure. The gauge automatically subtracts atmospheric pressure from absolute pressure to give the pilot his fuel pressure in pounds per square inch *(Gauge)*.

3—THE DESIGN PROBLEM

Quick, accurate response to ever-changing air pressure is a "must." And with new aircraft able to climb almost a mile-a-minute, it takes a bellows of good design . . . and good metal . . . to smooth out the accompanying acrobatics of air pressure.

PICKING THE BEST METAL

On the basis of the required *mechanical* spring properties, several metals *could* have been used for the bellows. But an instrument of such high accuracy and hair-trigger response demanded more than that. The metal also had to supply the necessary strength . . . resistance to rusting and corrosion . . . resistance to corrosion fatigue. Moreover, the metal had to be available in the uniform gauges and tempers required.

In INCONEL, an INCO Nickel Alloy, Ranco found all these properties . . . *and more.*

32 BRAZED CONNECTIONS

That *"more"* was Inconel's workability. For fabrication of the tiny bellows unit (out of 1-in. wide, 0.010-in. gauge, half-hard temper Inconel strip) involved deep drawing . . . *and 32 brazed connections!*

Inconel filled the bill perfectly. And thanks to Inconel's excellent brazing qualities, less than one out of every thousand joints showed any leakage under test.

Whenever you need a hard-to-find combination of properties, remember the family of workable INCO Nickel Alloys. They'll help you fight stress . . . wear . . . fatigue . . . rust . . . corrosion . . . heat. For more information on Inconel, write for "Engineering Properties of Inconel." The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

get to know all the

NICKEL INCO TRADE MARK ALLOYS

MONEL* • "R" MONEL* • "K" MONEL* • "KR" MONEL* • "S" MONEL* • INCONEL* • NICKEL • "L" NICKEL* • "Z" NICKEL*

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods . . . (Gas and Electric) *Reg. U. S. Pat. Off.

the country will start giving a great deal more time and attention to the retail phase of their business, and stop wasting time searching for the long discount, which may end up as no discount when true postwar conditions come into operation.

This is not intended to disparage the merits of an airplane parts distributing business, or of an airplane distributing business from an operational or from a profit standpoint. Both businesses are perfectly sound and reliable when intelligently and carefully operated. There will be many people who will continue to be successfully engaged in the operation of a wholesale aircraft parts business, as well as a wholesale airplane business.

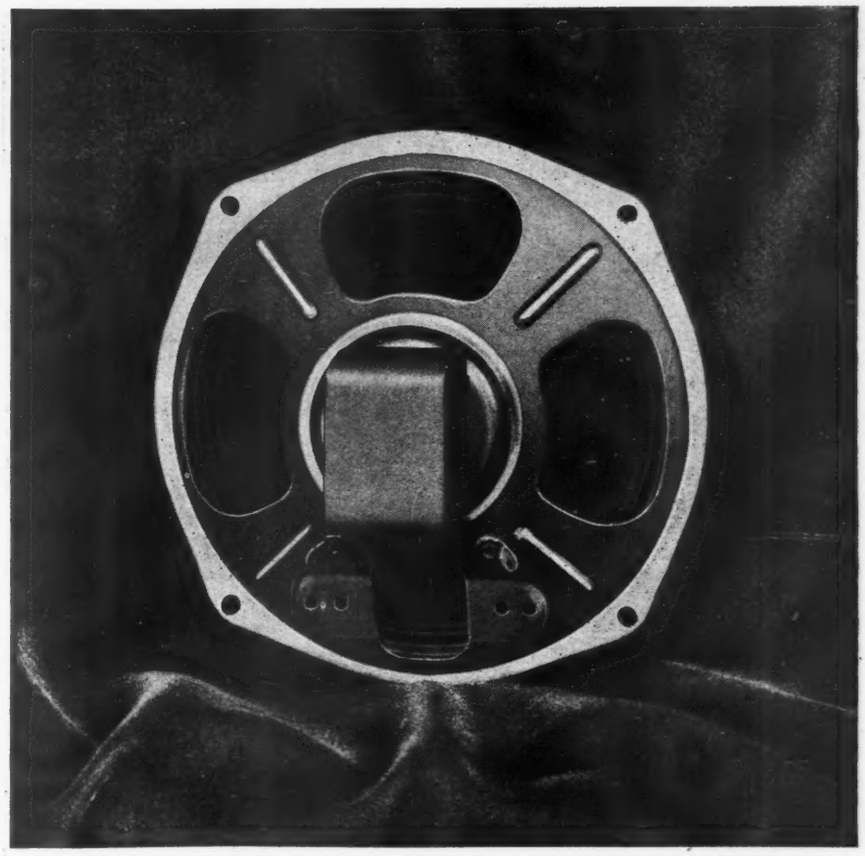
It is, rather, intended here to emphasize the point that not everyone can be a distributor, since each distributor must be supported by a large group of enthusiastic and loyal retailers. It is intended to point out that the retail end of the business can be as profitable, or more profitable in many instances, than the wholesale function. And retailing often lends itself better to the typical business of the fixed base operator.

While it is unquestionably true that the sales practices of manufacturers and distributors in the prewar period were largely responsible for the present attitude of established operators, it is equally true that many manufacturers and a few established aircraft accessory distributors are now a step ahead of the operators in anticipating postwar conditions. There are few aircraft manufacturers or aircraft accessory manufacturers in the country who would not welcome the announced intention of any fixed base operator to establish a strong retail sales organization.

Such an operator could successfully demand the cooperation of the airplane manufacturer as well as of the aircraft accessory distributor. If a large group of such operators got together, they could change the present unhealthy picture overnight, and through the tremendous pressure they could exert, correct any faulty policies still remaining on the part of the aircraft or accessory distributor.

Unfortunately, few operators today seem inclined to agree with this viewpoint, possibly because they do not appreciate their potential strength. It still is like pulling teeth to get them to enthusiastically establish any kind of a retail operation.

Even so, there are some indications that the trend will ultimately turn in the proper direction. We hope that any operators reading this article, who question the validity of the statements in it, will take the trouble to at least prove to themselves that these statements are either right or wrong. We hope those distributors who still sell direct to the



Maximum Performance with Minimum Magnet Weight!

Permoflux, with less than a 1½ ounce Alnico Five magnet weight, now achieves performance in permanent magnet dynamic speakers up to 6" obtainable only before by using a much *heavier* Alnico Five magnet.

Like other Permoflux developments that have as notably demonstrated their superiority, this new speaker design is destined to become an engineering standard wherever lightness of weight and efficient acoustical performance are important considerations.

We invite you to consider the advantages of this outstanding new Permoflux speaker development as applied to your own products.

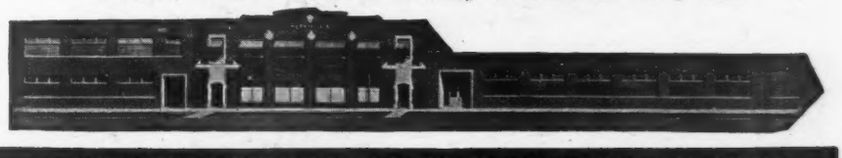
BUY MORE VICTORY BONDS!

TRADE MARK

PERMOFLUX

PERMOFLUX CORPORATION

4900 WEST GRAND AVE., CHICAGO 39, ILL.



PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

ANNEALING AND HEAT TREATING BASKETS

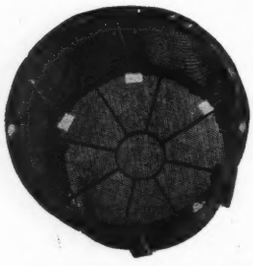
Any type of basket can be supplied with locking top or a bail and trunnions for hoisting and dumping.

Specialists to the Aviation Industry

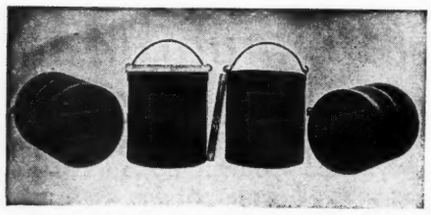
The rapid changes in requirements for Annealing, Pickling and Dipping Baskets in the Aviation Industry are an old story to our production engineers. Our plant facilities are flexible and can be quickly converted for the rapid production of small or large quantities of baskets to your specifications.

All baskets made by The Pressed Steel Company are of light gauge, welded alloy construction, strongly braced with ribs at all essential points affected by weight. They are built to last, and their initial cost is less than heavier equipment.

We can quote on your specifications or have our Plant Analysts prescribe for your needs.

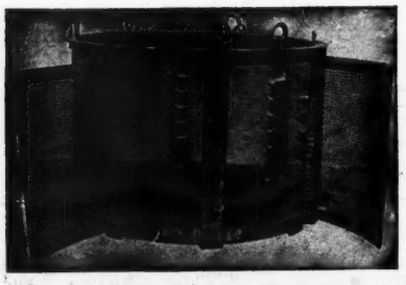


For annealing and quenching aluminum and manganese castings. Furnished in various types to your specifications.



Pickling or Dipping Baskets can be made of stainless steel if desired.

Heavy duty baskets with slatted sides of any thickness of metal, and a perforated bottom, can also be supplied equipped with lifting bail and trunnions for easy dumping.



Annealing and Heat Treating Basket 6 ft. in diameter and 6 ft. high with adjustable shelves and sides.

THE PRESSED STEEL COMPANY

OF WILKES-BARRE, PENNSYLVANIA

BRANCH OFFICES: 312 Curtis Bldg., Detroit; 503 Nicholas Bldg., Toledo; 1915 Engineers Bldg., Chicago; 51 E. 42nd St., New York; 1005 Sterling Bldg., Houston, Texas; A & M Accessories Ltd., 19 Melinda St., Toronto, Canada; Broad St. Station Bldg., Philadelphia; 417 So. Hill St., Los Angeles.

PRESSED STEEL COMPANY PRODUCTS: Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application, Radient Tubes, Inner Covers and Base Sheaths for Steel Mills.

consumer will correctly read this as the handwriting on the wall. Both can count on enthusiastic help from all progressive manufacturers in the establishments as well as support of adequate retail outlets.

Selling Block Time

(*Continued from page* 108)

produced by a local print shop instead of buying a stock number and having the operator's own particular printed information added to it.

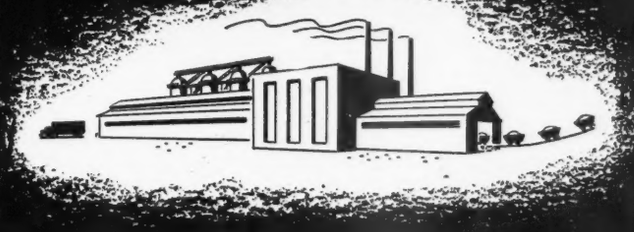
Now, it would seem, everything is ready for the block time sales rush. But do people come rushing in waving hundred dollar bills? No. Why? Because they don't know about the idea of buying block time. It would be the last thing in the world which they would think to investigate. So the operator must tell them about it and this means just one thing—advertise. There are one or more daily or weekly newspapers or magazines which circulate through the local trading area. And in this matter of advertising, the local radio station and the good old fashioned direct mail method should not be overlooked. The cost of a few spot announcements on the radio will be very low and one or more direct mail circulars will not cost too much, even including the postage which will be used. Printed matter goes third class mail so it is cheaper than first class letters.

There's another point in this direct mail matter. Addresses may be hand picked. Publications and radios reach everybody, but when it comes time to make up the list for the direct mail ads, the phone book offers a perfect source. All those listed there are affluent enough to pay for a telephone, so they won't be exactly paupers. Further, knowing the city as a native makes it possible to pick out the addresses which are spotted in the more well-to-do parts of town. This is tedious work, but most flight schools have a clerk who can keep herself busy on it. The boss, too, can take a hand, as can pilots on those days when weather curtails flying.

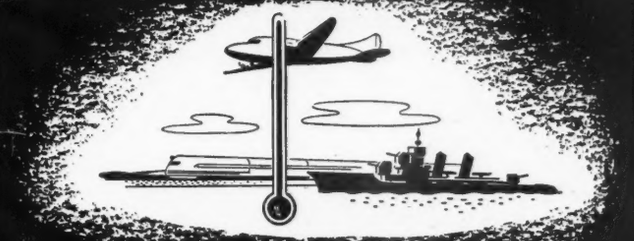
Flying time is not the only thing which can be sold via gift certificates. Goggles, computers, log books, all of which cost less than flying time, are available so a child could give them to a flying parent or older brother or sister. These less expensive gifts are salable to non-flyers who have friends among the aviation fraternity to whom they might give something of low cost. All these items should be mentioned in the advertising. Most of this business will lend itself to handling through the mail or over the phone. The prospective gift giver phones, the flight school tells

THERMOTECHNICS...

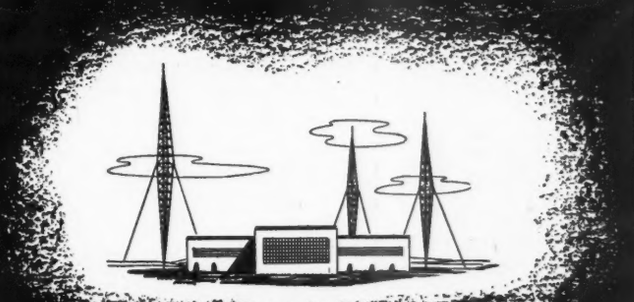
IS IT METALLURGY?



IS IT A THERMAL SCIENCE?



IS IT A METHOD OF COMMUNICATION?



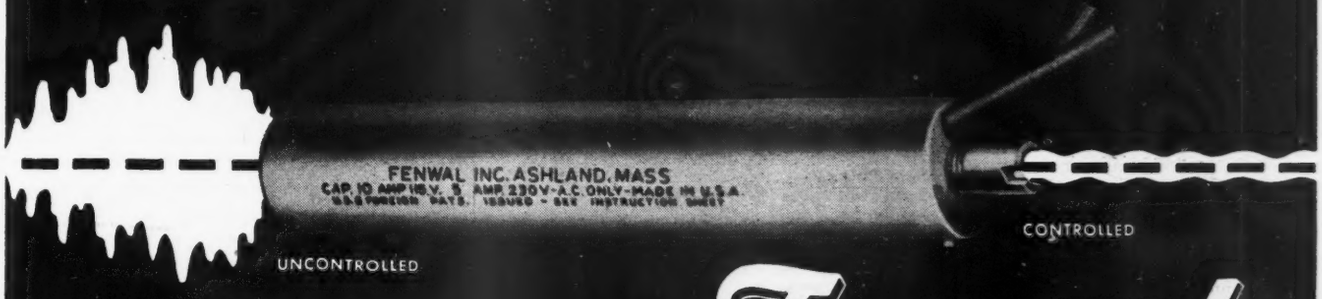
THERMOTECHNICS—a new art in temperature detection . . . based upon known phenomena of the expansion and contraction of metals; it includes regulatory media that harness temperatures to industry's bidding; and, it communicates silently and invisibly critical observations by the action of THERMOTECHNICS' unique instrument, the THERMOSWITCH, and directs appropriate action.

HAVE YOU LOOKED INTO THERMOTECHNICS? DO YOU KNOW WHAT IT CAN DO FOR YOU?

To learn about THERMOTECHNICS, send for the latest brochure which will be mailed to you upon request...of course, no obligation. Then fill out the information sheet which is enclosed with the brochure and submit the data to our THERMOTECHNIC Analysis Group which will be glad to make a THERMOTECHNIC analysis of your problem and submit the most effective application of THERMOSWITCHES to your specific requirements.

Fenwal

IT IS ALL THREE!



Today, THERMOTECHNICS serves a thousand industries, from aviation to x-ray equipment.

THERMOTECHNICS can serve you too . . . economically, efficiently, simply and ruggedly.

Fenwal
INCORPORATED
THERMOSWITCHES
FOR COMPLETE TEMPERATURE CONTROL
17 Pleasant Street, Ashland, Massachusetts

never GAMBLE ON FIRE PROTECTION...

STANDARDIZE YOUR EQUIPMENT WITH PYRENE

You gamble with fire when you install only one type of extinguisher if you have hazards that call for two or more different types. Today's production, industrial growth and building expansion ought to have the maximum fire protection provided by Pyrene equipment. Specifically designed, tested and approved for each particular hazard it will give you maximum fire protection where and when you need it. Determine now whether you have adequate fire protection—if your extinguishers are ready to meet any emergency. Ask your Pyrene jobber to show you how to properly protect your property.

for class A fires
WOOD, TEXTILES, RUBBISH, USE PYRENE SODA-ACID, FOAM, CARTRIDGE-OPERATED OR PUMP TANK WATER AND ANTI-FREEZE TYPES.
for class B fires
Pyrene FOAM
GASOLINE, PAINTS, OILS AND FLAMMABLE SOLVENTS, USE PYRENE FOAM AND VAPORIZING LIQUID EXTINGUISHERS.
for class C fires
ELECTRICAL EQUIPMENT WHERE EXTINGUISHING AGENT IS A NON-CONDUCTOR, USE PYRENE VAPORIZING LIQUID EXTINGUISHER.

Pyrene Manufacturing Company
NEWARK 8 NEW JERSEY
Affiliated with the C-O-Two Fire Equipment Co.

the story, suggests a check or money order be sent immediately so the gift certificate can be promptly mailed.

Now, as never before and probably never again, the banks are full of pent up money—money which wants to come out and be spent. It is money which is a threat of inflation unless it is placed against goods or services for future delivery, which is exactly what this plant suggests; money which will buy few consumer goods because there are so few available at present. It is money which can buy flying time for future delivery from any operator who pushes the block time gift certificate idea.

Knack of Survival

(*Continued from page* 102)

ing a suitable place, he scooped out a bed in the desert, complete with sand pillow, then covered himself with sand and went to sleep.

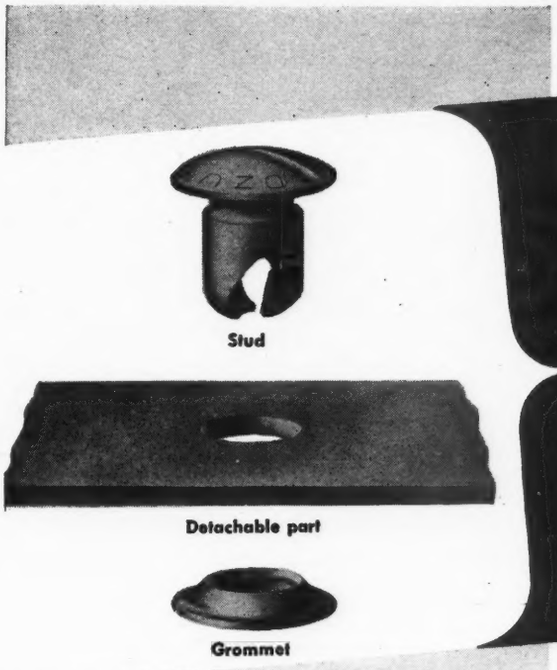
Lt. Zolnier arose early on the morning of the 19th and after securing more cactus juice and pulp, continued his southwestward march. He was quite surprised to find that what showed on the map as numerous streams were nothing more than dry beds; at each one of these, he turned rocks and dug down to try to find water, but this was never successful.

During his morning hike, Lt. Zolnier saw a dark brown snake with a black stripe down the middle of its back. This reptile, which was approximately 7 ft. long and of about 3 in. dia., was sunning himself, and would, Zolnier thought, make a wonderful dinner. With the large tree-branch club he had fashioned, plus a stone, he began to approach the snake. But the reptile saw Zolnier, decided the dinner should be reversed, and began an immediate pursuit. The pilot finally eluded his aspired chow, and continued his journey; somewhat more tired but wiser for the incident. With the coming of mid-day, he again stopped to rest.

After a few hours of relaxation, the lieutenant, despite the heat of mid-day, decided to try walking to occupy himself. After pushing on for a time, the heat began to tell and for the first time his eyes began playing tricks on him.

Thinking back over this phase, he remembers walking up a small incline, but suddenly, as he stared ahead, the ground appeared unusually level, and it then seemed as if an ocean were in front of him. Not sensing any danger, he continued walking—then suddenly found himself falling. While hurtling through space he noted a lack of the usual tendency to grab for objects, but instead was perfectly relaxed, and as a result his only injuries were scratches

NEW INSTALLATION METHOD FOR DZUS* FASTENER STUDS CUTS ASSEMBLY TIME 50%



Shown above are the component parts and steps in the assembly of the Dzus spiral cam fastener, using the newly designed grommet.

A newly developed Dzus grommet slashes installation procedure about 50%. This speeds up the assembly of Dzus fasteners for mass production operations.

This is the way it works. Dzus fastener studs are placed in the holes drilled or punched in the material to be fastened. The grommet is then slipped over the end of the fastener stud and flattened with a single tool. **All types of Dzus fasteners may be installed in this manner.**

If you have a fastening problem on a hinged or removable part, let a Dzus engineer help you. There is a Dzus fastener to meet every requirement.

*The word Dzus is the registered trade mark of the Dzus Fastener Co., Inc.

DZUS FASTENER CO., INC.

BABYLON • NEW YORK

IN CANADA: RAILWAY AND POWER ENGINEERING CORP., LTD.

Electricity

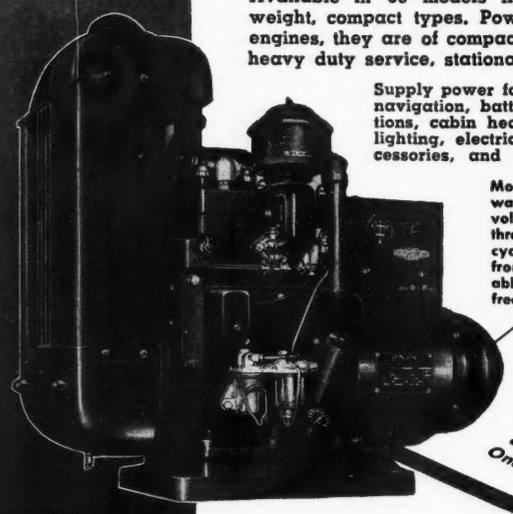
ELECTRIC PLANTS Onan

TO MEET AVIATION AND AIRCRAFT INDUSTRY POWER NEEDS

ONAN ELECTRIC GENERATING PLANTS provide power for many applications in the aviation industry. Available in 65 models including airborne, lightweight, compact types. Powered by Onan gasoline engines, they are of compact, single-unit design. For heavy duty service, stationary or mobile.

Supply power for starter energizing, radio navigation, battery charging, communications, cabin heating, airport and general lighting, electric repair tools, aircraft accessories, and many other applications.

Models range from 350 to 35,000 watts, A. C. types from 115 to 660 volts, 50, 60, 180 cycles, single or three-phase and 400, 500 and 800 cycles, single phase. D. C. types from 6 to 4000 volts. Also available in dual voltage and special frequency types.

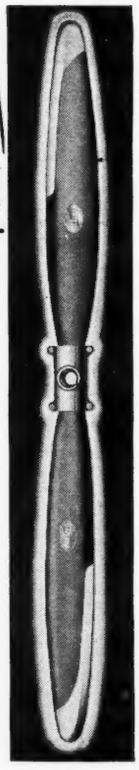


Write For Folder 690-A describing complete Onan Line

Model shown is from W2C series: 2000 to 3500 watts; powered by Onan two-cylinder, water-cooled engine.

D. W. ONAN & SONS
3142 Royalston Ave. Minneapolis 5, Minn.

It's PLASTIC-BASE Hartzite! It's Adjustable Pitch! It's for Light Planes!



The new plastic-base Hartzite ground-adjustable propeller for light planes definitely improves performance—noticeable the instant the plane is in the air. Greater speed, better climb, greatly reduced vibration and less noise are obtained with this new propeller.

It is easily adjusted to gain just the performance wanted—economy, speed, quick take-off. It possesses very high strength with very low weight; it has very high fatigue-damage limits; it will not weather-damage. We think it's one of the great post-war developments which aviation needs for full progress.

HARTZELL

But we have a plan which will allow you to decide for yourself. May we explain it?

WRITE FOR COMPLETE INFORMATION OR SEE YOUR DEALER

HARTZELL PROPELLER CO.

DESIGNERS AND MAKERS OF AIRPLANE PROPELLERS AND ENGINE TEST CLUBS

480 HEITZMAN AVE., PIQUA, OHIO, U. S. A.

and a sprained wrist. Lt. Zolnier had tumbled down the side of a 100 ft. cliff.

At a later time, when the ground searching party reached the spot, the doctor attached to the group was the only one to attempt climbing down this cliff, and he reports that the task took two hours to complete.

Picking himself up after the fall, in a slightly dazed frame of mind, Lt. Zolnier continued his walk for about an hour, at which time he decided it was wrong to walk in the hot sunlight, so he found a shady spot and once again removed his clothes to rest. Suddenly it occurred to him that he should check to see if he had received any broken bones or other damages from his fall. Finding no injuries, he fell into an exhaustive sleep.

Upon waking later in the evening, it was once again cool enough to continue his journey, which he did without further incident, satisfying his hunger and thirst with the barrel cactus juice, roots, and pulp. With the approach of night, he again made a bed of sand and slept.

On the morning of 20 May, he arose early and set out in search of food to allay the pains of hunger now annoying him. Once again remembering the survival training film, he set out in search of birds' eggs, but could find only empty nests. Stray jack rabbits approached him and eyed him curiously, but he could not get close enough to kill one. So he was again forced to turn to cactus juice and pulp to overcome thirst and hunger.

Expecting at any moment to sight the Colorado River, he continued his journey. As the heat increased, he stopped for his usual rest in the shade of desert shrubs. After making himself comfortable, he began to see visions of the MBDAG-43 swimming pool and gallons and gallons of water. Whenever these thoughts passed through his mind, he turned to his rosary and repeated prayers, one after the other, to occupy his mind and reinforce his faith in rescue.

While resting in the shade, Zolnier saw a brown lizzard approximately 16 in. long, pass overhead on a limb of his shade tree. Moving cautiously, he picked up his club and with one blow felled his first desert dinner. With his belt-buckle knife he skinned the lizzard and devoured the white flesh as well as selected entrails, also the eyes. The lizzard was quite edible and tasted like a sardine. Though he had felt his strength slowly ebbing from him in the last few days, new life seemed to enter his body after the fresh meat dinner. The desert was quite full of tremendous flies, and when one of these approached closely, the pilot caught it, and after stripping it of legs and wings promptly devoured it. Though not bad, Zolnier reports the fly was not as tasty as the lizzard flesh.

With the approach of the cool after-

noon hours, the pilot resumed his hike. The afternoon brought many clouds, and Zolnier had hopes of rain. As darkness approached he lay down in the cool sand and pebbles of a dry stream bed with the thought that if it rained he wanted to get his share of it. But as the night wore on the clouds slowly disappeared and the stars came out, leaving Zolnier once again disappointed. He then retired to a more comfortable sand bed under a desert bush.

On the morning of 21 May, the lieutenant arose early as usual and strode on. He climbed a high hill, at the top of which he found a large Army artillery gun-fire marker. As he leaned against this and scanned the skies he saw a liaison plane methodically scouting the area he had just crossed. Deciding that if the plane continued its search it would fly directly overhead, Zolnier ripped the braces from the back and sides of the marker, leaving it standing on its two heavy legs. As the plane approached, Zolnier began pushing the marker back and forth in a waving motion to signal the pilot. In the plane, Lt. Williams who had started his search with the first rays of dawn, saw the waving marker and upon approaching to investigate discovered the missing pilot.

Dropping a canteen with approximately two swallows of water in it, and a note telling Zolnier to remain at his present position until help arrived, Lt. Williams flew on to try to get the attention of the ground searching party. But failing, he continued to Camp Horn—approximately 17 mi. from the lost pilot's position—where he requested a doctor and helpers to drive out in a jeep and an ambulance. Flying in front of this vehicle-party as a guide, Lt. Williams soon led the party to the lost pilot.

Upon arrival, first aid was administered to Zolnier. In the meantime, other planes had located the pilot, and his position was radioed to the ground searching party, which arrived within 15 min. after the call. The pilot was located at 0175, and after approximately one hour spent in first aid, he was taken by ambulance to Datelan Field, where he was hospitalized.

The ground searching party reported being approximately two miles behind the lost pilot on the morning of the 21st. Had Lt. Zolnier not been located by Lt. Williams, the ground party would have overtaken the lost man on that date.

In all of his wanderings, it was estimated by the trackers that Lt. Zolnier had covered about 140 mi. Though he had lost approximately 36 lb., he was, nevertheless, in good condition when rescued. He was not as sunburned as one would have expected, since he had kept his clothes well buttoned and wore helmet, goggles, and gloves at all times

The first and the thousandth...
EXACTLY THE SAME!

Precision dies and precision methods at Booth's produce felt parts of consistent accuracy.

Add to this our high standards of quality plus prompt, interested attention to all orders, small or large, and you've a picture of the kind of service you get from Booth.

●

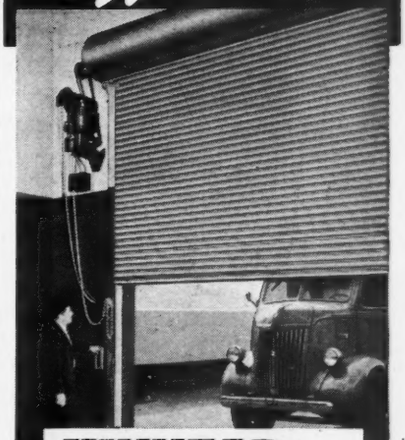
APPLICATION CHART AND SAMPLE KIT... *contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)*

THE BOOTH FELT COMPANY
482 19th Street Brooklyn 15, N. Y.
745 Sherman Street Chicago 5, Ill.
2321

Booth
TRADE MARK

PRECISION CUT FELT PARTS

Opening for Efficiency!



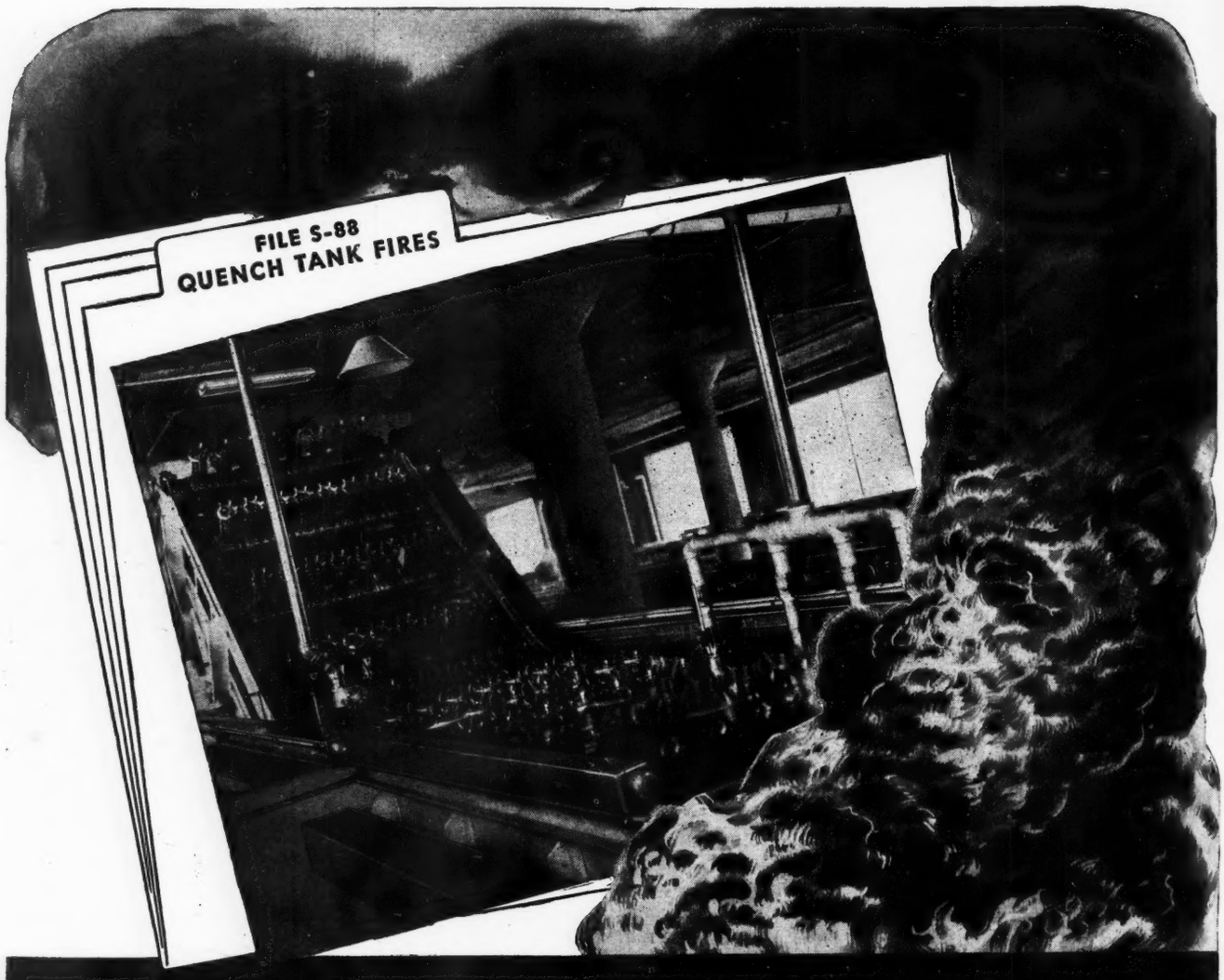
KINNEAR . . .
STEEL ROLLING DOORS

Every doorway gives you an "opening" for more efficient traffic and materials-handling, shipping or warehousing. Just install sturdy, dependable KINNEAR Steel Rolling Doors. They feature a flexible, interlocking steel slat curtain. That curtain coils upward into a small roll, remaining out of reach of damage when open. KINNEAR Motor Operator offers quick, labor-saving, push button control.

KINNEAR ADVANTAGES
Rugged all-steel construction
Coiling upward action
Effective counterbalance
Flexible interlocking steel-slat construction
Motor operation, with remote control if desired
Individually engineered for each opening
Many others

THE KINNEAR MFG. CO.
1440-60 Fields Ave., Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, California

KINNEAR ROLLING DOORS
Saving ways in Doorways



from the CARDOX case record...

Out of actual on-the-job fire experience comes evidence that Cardox Fire Extinguishing Systems give carbon dioxide a scope of usefulness, and fire extinguishing performance, far beyond the generally recognized advantages of this fast, non-damaging, economical extinguishing medium.

File No. S-88, taken from a user's report to another organization on Cardox extinguishment of a quench tank fire, offers an interesting example of Cardox performance on one of many types of hazard most effectively protected by Cardox CO_2.

"Our Cardox System, utilizing a ½-ton CO_2 storage unit, protects three hazards—an oil and lacquer storage building, a 950-gallon oil quench tank located in the heat treating departments, and a 1500-gallon oil quench tank located in another building.

"Recently we had a fire in the 950-gallon quench tank. Oil in this tank became ignited when a wire located in the switch cable broke while a 300-lb. steel basket of parts was being lowered into the quench tank at 1400° F.

"The Cardox System was actuated manually, and the fire was extinguished in less than 1½ minutes. Proof that we are completely sold on Cardox is found in the fact that we have ordered an additional Cardox System to protect a new addition we are now building."

The danger spots in your plant may not be similar to the one described in File S-88. But, if they involve flammable liquids or electrical equipment of any kind, Cardox offers a new scope of protection—making fast-acting, non-damaging carbon dioxide available in *tons* for large fires—in *pounds* for small ones—with ample reserve for new emergencies.

Before fire strikes to endanger your vital production plans, find out how Cardox has broadened the performance scope of carbon dioxide to set a new high standard of protection for many of the most severe hazards in American industry. An analysis of your fire hazards by Cardox Research Division and Engineering Staff puts you under no obligation. Write for Bulletin 316.

CARDOX CORPORATION
BELL BUILDING • CHICAGO 1, ILLINOIS

District Offices in
New York, Washington, Detroit, Cleveland, San Francisco, Los Angeles, Pittsburgh, Seattle, Philadelphia, San Diego, Houston

Cardox CO_2 is supplied instantly in pounds or tons from a single Storage Unit containing 500 pounds to 125 tons at controlled low temperature of 0° F. and 300 p.s.i.

CARDOX
CO_2 FIRE EXTINGUISHING SYSTEMS

during his journeying. Due to excellent composition of his field shoes and socks, his feet were in good condition, and he did not suffer a single blister on his feet.

Many scratches were received from thorns of one species of cactus, which clung to, and worked through, his clothing, including shoes, whenever he came into contact with them. His condition was aided by the use of the cactus juice, and Dr. Glenn, who accompanied the ground searching group, reports that the pilot could have continued for days on this diet. Contrary to the doctor's opinion, Lt. Zolnier thinks he would not have lasted more than a couple of more days had not the rescue been effected.

Lt. Zolnier reports that he was quite calm mentally nearly all of the time and was confused only the one time he had tried to march in the mid-day sun and had suffered his fall.

When asked for suggestions for pilots flying over the desert, Lt. Zolnier's reply was: "As for equipment, matches! And," he added, "never leave the spot of initial landing, under any circumstances."

Engine-Stock Position

(*Continued from page* 131)

up—from such industrial giants as General Electric and Westinghouse Electric. Others that may be in the foreground are Allis Chalmers, the Lycoming division of Aviation Corp., Packard Motors, and the Elliott Co.

In a recent comprehensive study on jet propulsion, the investment banking firm of Reynolds & Co. indicated that jet propulsion would make its most immediate inroads in the fighter plane category, with somewhat slower transition from reciprocating to gas turbine power plants in the bomber field.

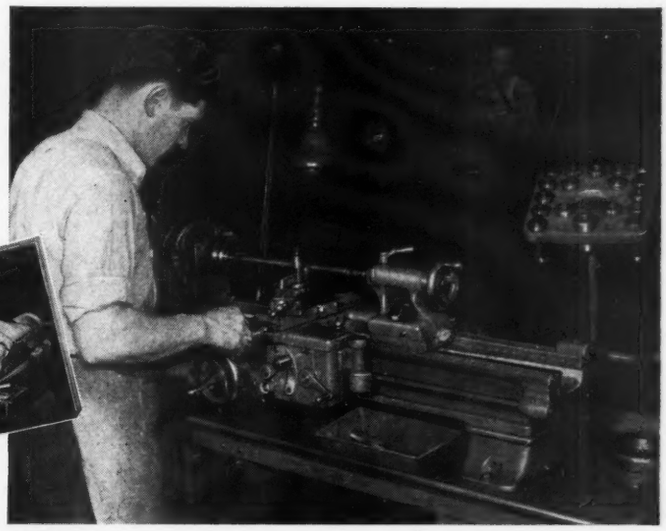
Gas turbine-powered military transport development is expected to closely follow that of bombers; both have the same job of carrying the greatest possible loads the longest possible distance. But here the transition from reciprocating to turbine engines will await the development of jet units which are more nearly equal in fuel-consumption efficiency. Speed is not as essential in transportation as it is in combat planes.

Some experts predict the gas turbine may become the dominant factor in the commercial transport field for powering major trunkline operations in 10 yr. time. But for the next 5 yr., at least, reciprocating engines will continue to have the trunkline market. Feederlines, where high speeds are not as essential, are not considered good turbine prospects. Nor will private planes provide an outlet for the jet in the next few years. The experts say, though, that

FACTORY ACCURACY
IN THE REPAIR SHOP

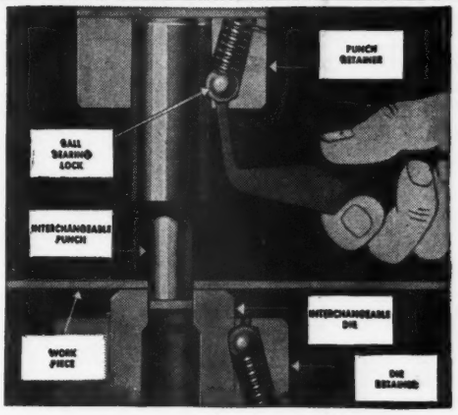
The nation's leading airlines depend on South Bend Precision Lathes to maintain factory tolerances, speed work, and keep costs down in base service and overhaul shops. Versatile and dependable, there is a model to serve your needs, too.

South Bend Lathe prices start at **$110.50** f.o.b. factory



Catalog 100-D illustrates all sizes, models, of South Bend Lathes, gives all specifications. Write for it today! It's Free!

SOUTH BEND LATHE WORKS
Lathe Builders Since 1906
503 E. MADISON STREET, SOUTH BEND 22, INDIANA



The Original Inter-changeable Punch and Die

● Allied's R-B Interchangeable Punch and Die lowers costs in the metal working and plastic industries. Standard punches and dies carried in stock. Special shapes and sizes in any material made to your specifications with prompt deliveries. Send for large illustrated R-B catalog, now.

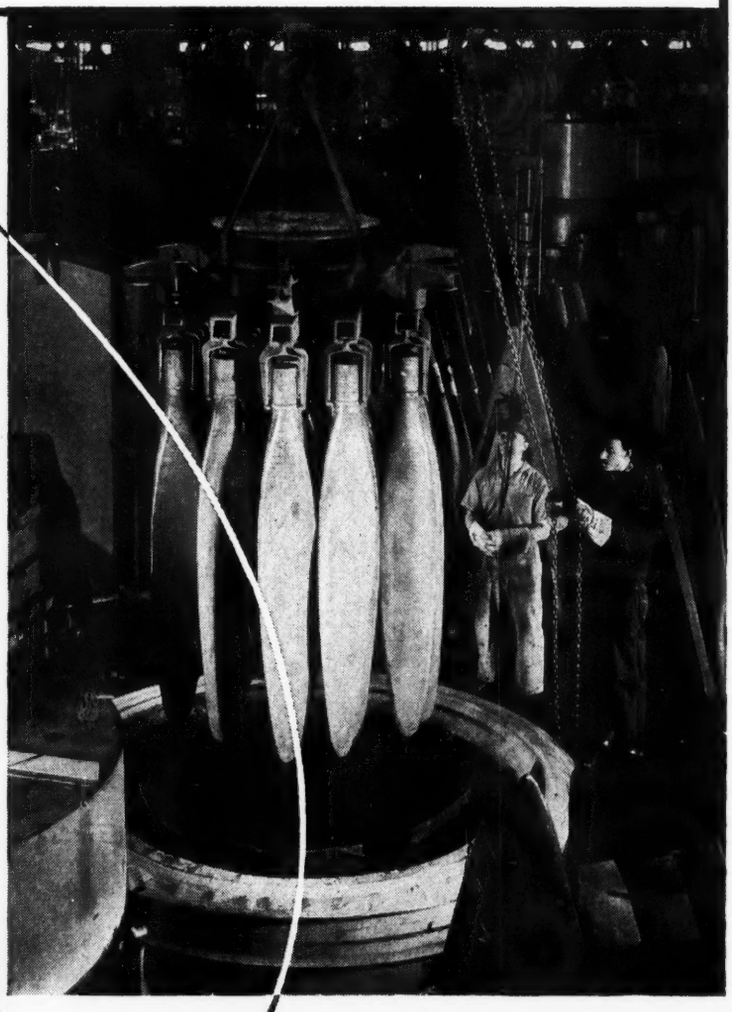
ALLIED PRODUCTS CORPORATION
Department 29B • 4614 Lawton Ave. • Detroit 8, Michigan

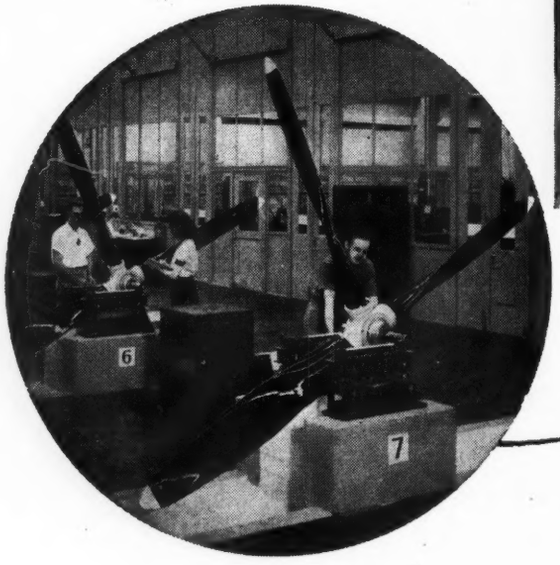
NICKEL STEELS *combine . . .*

EXCEPTIONAL MECHANICAL *and* FABRICATING PROPERTIES

SAE 4330 Nickel chromium molybdenum alloy steel was adopted for Curtiss propeller blades because of its high strength, toughness and good workability, coupled with a wide safe heat-treating range.

High velocity cooling is not necessary to properly harden SAE 4330 for this application. There is no warping to correct by cold-straightening operations nor danger from subsequent stresses that might cause failure in service, because the slow transformation rate of this steel permits hardening to the required degree by die-quenching; thus consequent savings in time and labor, and a uniform final product are provided.





Curtiss Propeller Division of Curtiss-Wright Corporation, one of the largest producers of constant speed propellers, fabricates blades by welding two plates of SAE 4330 into a hollow unit that permits weight saving over solid blades of light metals.

Inquiries on the use of Nickel alloy steels or other alloys containing Nickel in your products or equipment, are invited.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

there may be a few production models within the next 5 yr., and many small planes may be using jet in another 10 yr.

All this projection leads to the question of how the present engine builders stand on jet. Naturally, they are keeping precise developments along this line pretty well under wraps. However, Pratt & Whitney is known to be developing gas turbine engines of its own and is cooperating with Westinghouse on axial-flow types. Curtiss-Wright also is actively developing a gas turbine engine while Allison has been making General Electric-designed jet engines for the Lockheed P-80 fighter.

So the old-line reciprocating engine builders appear to be active in the jet propulsion field along with several others. Now let's see how their operations shape up otherwise.

United Aircraft estimates its annual postwar sales at $120,000,000 or better on the expectancy that postwar business will be roughly three times the $40,000,000 prewar figure. Official estimates are not available on the company's present backlog of unfilled orders, but trade estimates place it from $115,000,000 to $125,000,000, a rather far cry, of course, from United's $800,000,000 wartime backlog.

Military production includes propellers, helicopters, engines, and about 20 Vought Corsair fighters a month. The Pratt & Whitney division's R-2800 engine and the new Wasp Major are not on the Army's list of surplus equipment.

The Major, with its 3,650 rated combat horsepower, is slated to be installed in new transport planes which Douglas, Republic, Boeing, and Martin are bringing out. When General Electric officials recently asserted that their I-40 jet engine used in Lockheed's Shooting Star was the "world's most powerful aircraft engine," a United official retorted that while the jet may produce more propellant force at speeds above 350 mph., it did not equal the Wasp Major at lower speeds. And commercially, he observed, few airplanes are designed to fly more than 350 mph. at present.

Curtiss-Wright Corp. had unfilled war orders of $1,850,000,000 on V-J Day. Of this huge amount all but $100,000,000 was cancelled shortly thereafter. When a small commercial backlog is added, the company has total unfilled orders of around $115,000,000. Unlike United Aircraft, Curtiss-Wright hopes to augment future earning power by branching out into non-aircraft and allied fields.

A little speculative flavor has been added to the Curtiss-Wright stocks by recurring reports of a pending merger with Lockheed. There have been "conversations," but it remains to be seen whether anything definite will eventuate.

Despite their greater rise in 1945, the

STARRETT

STARRETT Precision Is Part of the Picture at FAIRCHILD

Before a single ship takes wing, hundreds of precision measuring and inspecting operations must be made. *Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation* uses many Starrett Precision Measuring Tools as evidenced by the above pictures taken at their Hagerstown, Maryland plant. Skilled workers at Fairchild, as everywhere, have learned that they can count on Starrett accuracy and dependability to do better, faster work.

Ask your mill supply distributor for Starrett Tools

Now, with 4 Service Stars

THE L. S. STARRETT CO., Athol, Massachusetts, U.S.A.

World's Greatest Toolmakers

Precision Tools . . . Dial Indicators . . . Ground Flat Stock

Hacksaws . . . Metal Cutting Bandsaws . . . Steel Tapes

Elliotts

Direct Printing Papers

WHITE BACKGROUND

LIN-O-BLU

LIN-O-RED

LIN-O-BLACK

BEST BY TEST

The names Lin-O-Blu, Lin-O-Red and Lin-O-Black are descriptive of the color of the lines. *Lin-O papers are made of 50% rag stock for greater strength—printing is true to scale—and developing is with ammonia or other alkaline vapors. These papers—best by test.

*LIN-O IS OUR REGISTERED TRADE MARK FOR DRY DEVELOPED DIRECT PRINTING REPRODUCTION PAPERS.

"DT" Reproduction Tracing Cloth

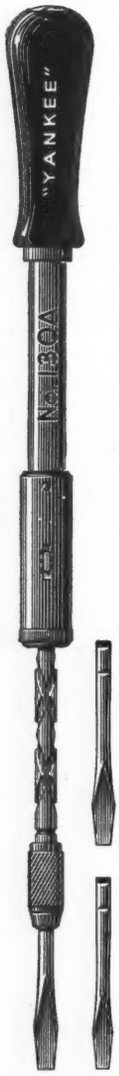
Makes best reproduced tracings—fast printing—wide range—very transparent—permanent lines. Write Dept. H-6 for samples

B. K. ELLIOTT COMPANY

DRAWING MATERIALS—SURVEYING INSTRUMENTS

Pittsburgh • Detroit • Cleveland

RIGHT TO THE POINT!



From hardwood-handle to tempered-steel blade, every "Yankee" spiral screw driver is right to the point. Every part is ingeniously designed to speed work, cut down man-hours. Painstaking design and simple strength are typical of *all* "Yankee" fine mechanics' tools... whether Tap Wrenches, Vises, Automatic Drills, or Bit Braces. For more than fifty years, "Yankee" reputation for fast performance and reliability has grown steadily; and it is growing today, as "Yankee" tools help speed production.

Order from your industrial supply distributor, or write North Bros. Mfg. Co., Dept. A-146, Philadelphia 33, Pa.

"YANKEE" SPIRAL SCREW DRIVER No. 130A
A Size for Every Purpose

"YANKEE" TOOLS
make good mechanics better
North Bros. Mfg. Co., Phila. 33, U. S. A.
Established 1880

airframe companies still were cheaper in relation to assets than the engine companies. The reason, of course, is that the engine companies have larger capitalizations. But while they may not show up so well on a per share basis, the fact is that the engine companies are abundantly supplied with cash and working capital and have no worries in that respect.

All in all, this hardly seems the time to sell the major aircraft engine makers short. They are likely to have their innings again later on.

Mobile Dual Refueler

(*Continued from page* 105)

ferring 150 gallons of fuel per minute.

Moreover, an hydraulically operated telescopic lift with 4-ft. platform is incorporated in the Servicer. This lift can be extended to a 15-ft. level to facilitate handling of discharge hose and enable the refueling crew to work at wing level or, when necessary, to step directly onto the wing. The platform, equipped with a safety railing placed in position before the lift is extended, is fitted with sponge rubber bumpers to avoid damage to wing leading edge and de-icer boots. It is also practical for underwing refueling. Hydraulic lift and fuel pumps are powered by the Servicer's engine drive.

The unit is also equipped to handle defueling operations by pumping directly back into the underground low pressure feedlines.

Lubricating oil is handled in refillable containers or various-size sealed cans stored in a compartment at the same end as the hydraulic lift. A side compartment can be used for storing hydraulic oils, greases, and other supplies.

A seat is provided on each side of the steering wheel in the driver's compartment to enable the operator to face the plane as he approaches it, thus affording added safety.

It is believed that the Servicer—both because of its mobility and its ability to fuel and defuel at a high rate—offers a specific answer to present-day servicing problems. The unit, now being built by The Heil Co., Milwaukee, Wis., will be used at principal airports serviced by Intava Inc.—representing aviation interests, outside the U. S. and its possessions, of Standard Oil Co. (N. J.) and Socony-Vacuum Oil Co.

Private Enterprise Fights

(*Continued from page* 41)

vate operation of airlines; further, Great Britain, in its White Paper, plumped for private operation. Surely nobody believes that the Governments of those

IN AIRCRAFT VISION aided VICTORY

LIBERTY AIRCRAFT MIRROR

The pilots of thousands of Allied fighter planes over widely scattered battle fronts, received a perfect image of things behind them without eye strain or fatigue, by means of Liberty Aircraft Mirrors.

Liberty Aircraft Mirrors are all first surface mirrors, and as permanent as their glass base. They give the pilot a clean, well defined image without distortion, immediately.

Liberty Mirror can supply a mirror built to meet the specific requirements of a plane. Thus the pilot changing from one plane to another of the same make can be assured uniformly good vision at all times, in all planes.

All Liberty Mirrors are battle tested vision devices. They are now available to all operators, military, transport or private.

Write

LIBERTY MIRROR DIVISION

LIBBEY-OWENS-FORD GLASS COMPANY
BRACKENRIDGE
PENNSYLVANIA

For continued outstanding production Liberty has been granted a renewal of the Army-Navy Production Award entitling them to add a star to their "E" flag.

It is reported that . . . . . .

A technical magazine states that the war-developed arc-oxygen electrode will cut quarter-inch steel plate at the rate of a foot per second while under 40 feet of water. *Metal and Thermit Corp.*

get ready with CONE for tomorrow

It is estimated that within a few years 80% of the coal mined underground will be removed from the mines on conveyor belts instead of in cars. *Scientific American.*

get ready with CONE for tomorrow

The PV-3 helicopter has a long fuselage with a rotor on each end and carries twelve persons. It is being tested by the Coast Guard and Navy. *Popular Science.*

get ready with CONE for tomorrow

A new cement, for use in concrete flooring, is said to drive away insects, kill bacteria, and prevent the formation of molds. It also dissipates static electricity. *H. H. Robertson Co., Pittsburgh.*

get ready with CONE for tomorrow

An appliance manufacturer announces an electric washing machine that can also, by the use of attachments, wash dishes, peel potatoes, churn butter, and freeze ice cream. *Hurley Machine Division Elec. Household Utilities.*

get ready with CONE for tomorrow

A new gasoline-powered lawn mower resembles a floor scrubbing machine. It is mounted on four wheels and uses a rotary knife revolving at 3,000 r.p.m. *Whirlwind Lawn Mower Corp., Milwaukee.*

get ready with CONE for tomorrow

The manufacturer of the jet engine used in the P-80 Shooting Star prophesies that all transcontinental planes will be jet-propelled within five years. *General Electric.*

One of the war devices that may survive to help the motorist is the tire gauge that registers on the dash, developed for the Army's amphibious "duck." *GMC Truck and Coach Div.*

get ready with CONE for tomorrow

A magnetic survey of the state of Florida shows large areas in the southern part that are favorable for the occurrence of petroleum. *U. S. Dept. of Mines.*

get ready with CONE for tomorrow

Meals are being served in the Naval Air Transport Service that are pre-cooked, packed in a covered paper plate and frozen. On the plane they are thawed and heated in a special oven. *Maxon Sky Plate, W. L. Maxon Corp., 460 W. 34th St., New York.*

Air conditioned trolley cars are being introduced in a Southern city. This is said to be the first use of such equipment in city vehicle transportation. *Atlanta, Ga.-Pullman-Standard.*

get ready with CONE for tomorrow

A new household electric light switch can be set for delayed action up to three minutes. *T. J. Mudon Co., 1240 Merchandise Mart, Chicago.*

get ready with CONE for tomorrow

Rubber V-belts molded around a steel cable have been developed to replace chain drive on Army motorcycles. *Goodyear, Akron 16, Ohio, Whizzer Motor Co., Los Angeles.*

get ready with CONE for tomorrow

Even the common wire nail has been improved. The new type has a notch in place of the point and is claimed to be non-splitting. *E. S. Gair, Snyder, New York, inventor.*

countries are not cognizant of defense considerations? Airlines are not like railways or other static forms of transport which require long range development of facilities. The planes which fly from Melbourne to Sydney day in and day out can, at a moment's notice, fly direct to Perth or Darwin or Alice Springs or anywhere in Australia. The essential feature of civil aviation for defense purposes is to have the most efficient and most highly developed airline organization. It does not matter where the planes have been flying to, they will fly anywhere. That private enterprise is necessarily more efficient than Government enterprise will surely not be questioned.

At the beginning of this war it was the strength of the airlines under private enterprise which was Australia's strength in the air. The only modern planes were those of the airlines, which had obtained them not merely in face of Government apathy but in face of actual opposition. Incidentally these planes which had flown the Melbourne-Sydney-Brisbane run, etc., were, immediately on the outbreak of war, flown to Darwin and other strategic points—where they had never been previously—with troops and war materials. They were, at a moment's notice, flown to New Guinea to evacuate civilians. They had never flown there before. They were flown to the battlefields transporting commandos and taking supplies to beleaguered troops. They convoyed the first contingent of the AIF.

All this work they did because they were the only modern planes Australia had. They were flown by civil pilots who alone were trained for the machines. Had the airlines languished under the Government hand, as did the RAAF, a different story of the war may have been told. Their organization did all the repair and maintenance work for the USAAF when the struggle was on for air mastery of New Guinea. The Allied Air Forces won, and it was the civil airlines organization which kept their planes in the air.

"Toys" Proved Invaluable

One illustration of Government thinking, as opposed to private enterprise thinking, is illuminating. Before the war, ANA imported Link Trainers. The Government claimed duty on the machines, classing them, of all things, as a "mechanical toy." And no arguments would alter its view. When war broke out, they were the only apparatus of their kind in Australia, and they were diverted to the RAAF, where they performed invaluable service in our training program.

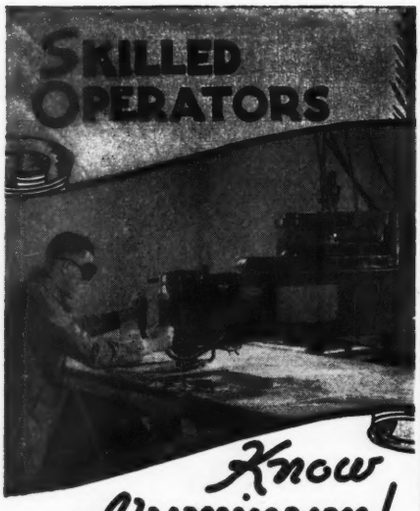
7. **Question:** As development of the interior is essential and as private airlines, which are profit-motivated, cannot be expected to fly non-profitable

A few of the bends in all types of metals that have been designed and made by Swan.
We concentrate on the thing we know best how to do. Among the specific applications of Swan services are—

All types of bends and coils
Exhaust, oil and hydraulic line assemblies
Inserts for die castings
Intake manifolds
Carburetors
Oil Lines
Frame Assemblies
Flash Welding, testing and bending of long tubes for condensers and heat exchangers

It will cost you nothing to consult our engineers on your tube bending problems.

SWAN ENGINEERING COMPANY, INC.
24-58 Nelson Street **Bloomfield, N. J.**



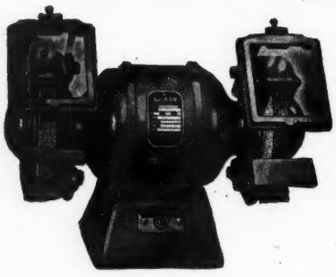
Know Aluminum!

Machines provide only the means for good craftsmanship . . . skill, based on long experience in handling aluminum in all its alloys, must guide the operation of these precision instruments.

Over 25 years of aircraft building has trained Mercury craftsmen; and this skill, and "know how" are now available for your products or parts manufacture.

MERCURY AIRCRAFT
ARMY-NAVY

BALDOR
BALL BEARING GRINDERS
for HEAVY-DUTY Service



BALDOR GRINDER No. 6110 has Capacitor Type ½ HP Motor guaranteed 2 yrs. against burn-out. 3400 r.p.m., 110 volt, 60 cy., single phase, 6" x ¾" wheels; enclosed guards; adjustable eye shields and tool rests. Net weight, 49 lbs.

Bench & Pedestal Types

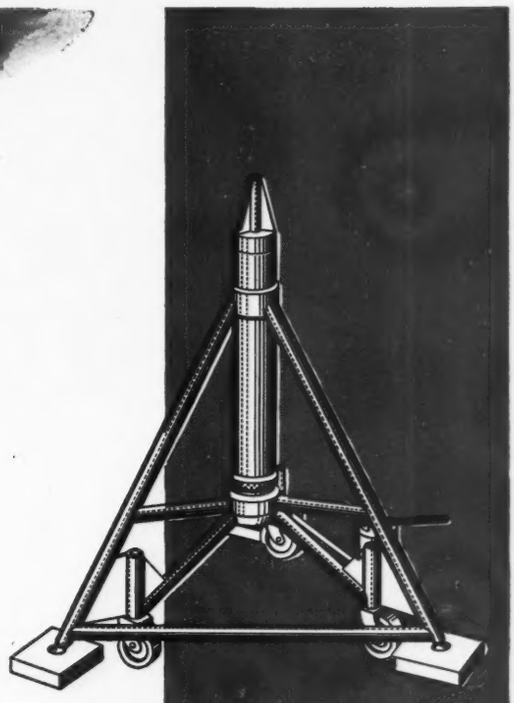
ASK FOR BULLETIN 321

BALDOR ELECTRIC COMPANY

4380 Duncan Ave. St. Louis 10, Mo.

BALDOR GRINDERS
built by Motor Specialists

Sky High



IT'S NEW—IT'S HYDRAULIC ALL THE WAY!

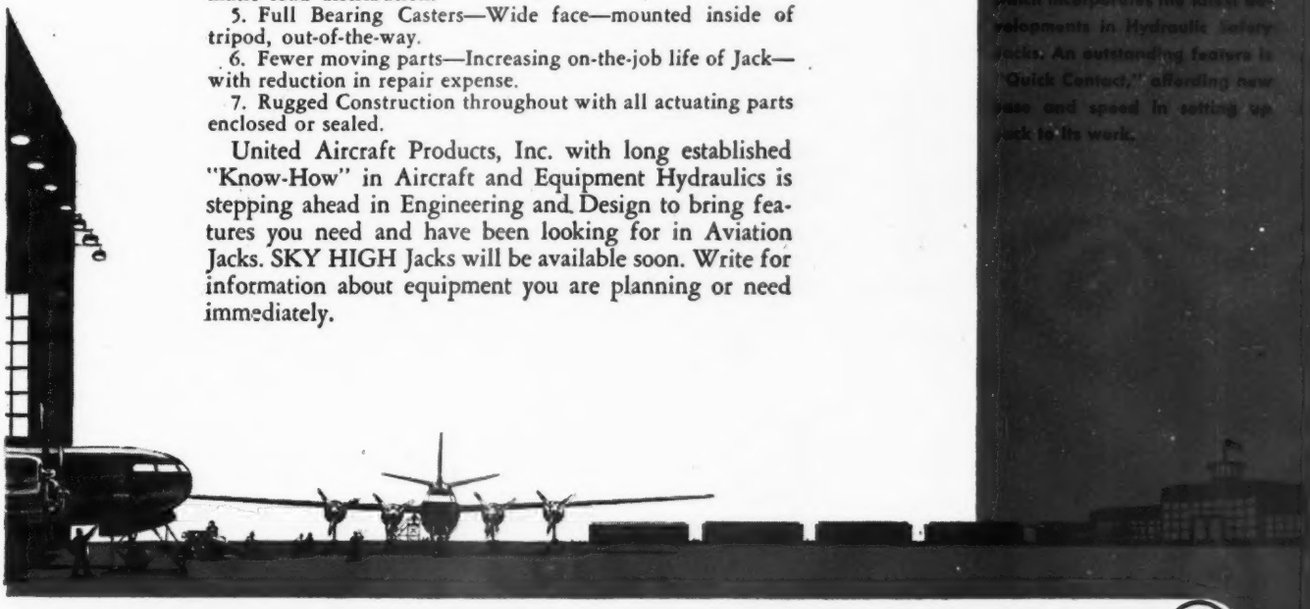
SKY HIGH Aviation Jacks contact the load, lift, hold and lower entirely through Hydraulics. All-Hydraulic is only one of many major features which makes SKY HIGH the most advanced Aviation Jack today.

Here are other SKY HIGH features to add speed, economy and safety to the handling of your plane repairs, overhaul and line maintenance.

1. Quick Contact—Exclusive, patented pumping mechanism, which gives almost instant contact with the load. No wasted time in raising plunger to contact the load and starting lift.
2. Single Pump and Reservoir—Does the work of two pumps even in multiple stage lifting. Pump-Reservoir combination is self-contained and readily detachable for other installations requiring hydraulic lifting.
3. Safety Lock Ring—Requires no up-or-down adjustment—Safety remains in same position at all Jack heights and locks by simple, quarter-turn of ring.
4. Load Equalizer Slide in Leg Base—Provides quick, automatic load distribution.
5. Full Bearing Casters—Wide face—mounted inside of tripod, out-of-the-way.
6. Fewer moving parts—Increasing on-the-job life of Jack—with reduction in repair expense.
7. Rugged Construction throughout with all actuating parts enclosed or sealed.

United Aircraft Products, Inc. with long established "Know-How" in Aircraft and Equipment Hydraulics is stepping ahead in Engineering and Design to bring features you need and have been looking for in Aviation Jacks. SKY HIGH Jacks will be available soon. Write for information about equipment you are planning or need immediately.

Following years of experience in Design, Engineering and Production of many Hydraulic Units for installation in Military and Naval Aircraft, and for their servicing and Maintenance, United Aircraft Products, Inc., now directs its experience and ability to the production of Aviation Jacks. Here is shown the new SKY HIGH Wing, Nose and Tail Jack which incorporates the latest developments in Hydraulic Safety Jacks. An outstanding feature is "Quick Contact," affording new ease and speed in setting up jack to its work.



UNITED AIRCRAFT PRODUCTS, INC.

SKY HIGH

AVIATION GROUND EQUIPMENT DIVISION • 2929 Santa Fe Avenue, Los Angeles 11, California
General Offices—Dayton, Ohio

● *BUILT BY P-V ENGINEERING FORUM, INC., Sharon Hill, Pa., this model PV-3 is the world's largest helicopter. It's 48' long and 13' high.*

ON THE FIRST TRANSPORT HELICOPTER

First helicopter designed for air transport operations, this two-rotors-in-tandem Model PV-3 is capable of carrying a crew of two and 10 passengers . . . lands in a 100′ diameter clearing on land or water. It's another great stride in Aviation taken with the help of SKF Bearings. For SKF are on the drive support and transmission locations —critical points that require dependable bearing performance. The product that's well-engineered is always the one that's SKF-equipped.

5940

routes, is not this sufficient reason for Government ownership?

Answer: The assumption that airlines will not fly non-profitable routes is faulty. They will and they do. They have done so for years. In fact, there is no inland or "never-never" center which is not served by airlines. To recite the list would require too much space, but here are a few of the better known places—

Western Australia: Wyndham, Fitzroy, Derby, Marble Bar, Wiluna, Ord River, and Mt. Magnet; *Northern Territory:* Darwin, Katherine, Daly Waters, Victoria River Downs, Tennants Creek, Tanami Granites, Alice Springs, Tempe Downs, and Mt. Doreen; *Queensland:* Iron Range, Normanton, Burketown, Cloncurry, Mt. Isa, Mitchell River, and Moonta; and *N.S.W.:* Bourke, Coonamble, and Toonaweenah.

The significance of the names chosen is that, as it will be appreciated, in the majority of instances, air transport is the only transport. There are no railways. Surely no one can say that such operations are not opening up the interior, and surely nobody thinks that the traffic in all those places pays dividends. The answer is that the airline industry—like every other transport industry—takes an overall picture. Non-profitable routes are operated and continuously expanded, and the only profit looked to is the over-all profit.

Non-profitable routes are operated, in some instances, with an eye to the future, even the far-distant future, and in many instances with the knowledge that they never will be profit-making in themselves. But in the overall result they may be, for the traffic carried along them at a loss may be carried farther along profit-making routes at a profit, and that profit may offset the loss. So long as the overall picture shows results, the operator is quite content.

The real tragedy of the Government's proposals is that if they are implemented this process of development cannot be continued. The Commonwealth power is limited to "inter-state" operation. It cannot, under the Constitution, engage in intra-state trade. All talk of the desire of the Government to develop civil aviation for the benefit of communications, for the development of outlying areas, and for defense purposes is completely misguided. The Commonwealth may operate from Melbourne to Sydney, or from any one point in one State to any other point in another State. Whether it may even operate from a point in the Federal Territory to a point in another State is doubtful. But one thing is certain: It cannot operate a network of airlines, such as is Australia's by right.

Take the network of one company, for example—the one connecting Melbourne, Canberra, Sydney, Brisbane, Rockhampton, Mackay, Townsville, Cairns, Cooktown, Coen, Iron Range, and Higgin's Field. That is from Melbourne to the top of Queensland. The Commonwealth may carry from Melbourne to Sydney. Canberra is doubtful. It may carry from Melbourne and/or Sydney to any one point on the route. It cannot carry between any of the points on the Queensland route. This intra-state traffic is vital to Queensland. What will happen to it? Will private operators fly the intra-state route side by side with the Commonwealth line, at least from Cairns, for surely there would be no traffic to warrant the Commonwealth going further?

Then how uneconomic would the position be with the Commonwealth planes half-full, at best, with inter-state passengers, and the private operator half-full, at best, with intra-state passengers? It would mean two lots of planes half-full instead of one lot of planes fully loaded—two organizations with their "overheads" to cater for only half the traffic. Neither will make a profit, as the taxpayer will soon appreciate. Continue this all over Australia and what an unholy picture of transport chaos you will get!

And who will develop the interior? The Commonwealth cannot. The private operator will not have the overall profit to enable him to do it. Development will be made upon a basis of subsidy payment to the private operator, at least until the Treasurer—with his losses on the Commonwealth line and losses to be subsidized on the private lines—calls a halt. When one considers how much air transport means to Australia, it is inconceivable that anybody could support the view that Government operation is desirable.

I would concede that arguments—in my opinion, unsound—exist for the theory of Government ownership in the abstract. But here is no proposition of ownership in the abstract but the concrete proposition of Commonwealth ownership under, and subject to, the limitation of the Constitution—ownership of, and ability to operate *only* in regard to, inter-state traffic. The concrete proposition of exercise of power is too limited to obtain anything that supporters of the proposal aim to achieve—on the contrary it means the destruction of all they seek to effect, and disaster so far as the development of air transport is concerned.

8. **Question:** As transport is a public utility would you agree that some Government control of air transport is necessary?

Answer: Certainly, but it is not generally understood that the civil airline companies are already subjected to the most rigid control through the Government's own authority, the Department of Civil Aviation. No commercial airliner can leave the ground until the Okay is given by the Department of Civil Aviation that all the conditions set forth under its regulations have been scrupulously fulfilled. These regulations cover every possible contingency for insuring the public welfare. They are clearly and precisely stated.

The Department is vested with absolute control over routes and stopping places; over fares and freights to be charged; over timetables and frequencies of service; over the rates to be paid to the companies for the carriage of mails; over the safety of aircraft; over crews and ground engineering staff; and over the methods of flying operations and air navigation.

No company can operate any route anywhere in Australia without first having obtained a license from the Department. If the Government owned the planes, it could not impose any more drastic or sweeping obligations upon its own servants than it places upon the civil airline operators. The companies possess no absolute and unfettered powers in any one of these matters but are subjecet to the over-riding authority of the Government.

9. **Question:** Will the airlines contest the legislation?

Answer: Definitely yes. First off, the people twice rejected a referendum seeking further Commonwealth powers over civil aviation. Therefore, there exists a public duty to determine the validity of the legislation.

Second, the airline operators know what air transport means in Australia. They envisage, and have indeed planned, a system of feeder services that will criss-cross the country, all to be operated without subsidy. They envisage no place on our continent more than 8 hr. from a capital city or more than 24 hr. from any other place on the continent.

Settlers of the far interior could tell you of questionnaires concerning the developments planned for them—questionnaires dealing with every transport aspect in relation to the marketing of products and the movement of personnel from outback properties. They deal with the problems of getting beasts to the point of sale in prime condition to insure top prices, also the advantages of local killing and freezing facilities. Hundreds of replies have been received, and the following statistics, based upon

No. 205P

When the helmet's **UP** *the shield's* **DOWN**

CONTINUOUS PROTECTION

TO CUT THOSE 29,700,000 LOST MAN DAYS*

Lost because of injuries to head and eyes in 1943. Supply workers with equipment they will wear—designed for *comfrt and protection*. Investigate Sellstrom safeguards now. At your jobber or write.

**Statistics from OWI and Nat'l Safety Council.*

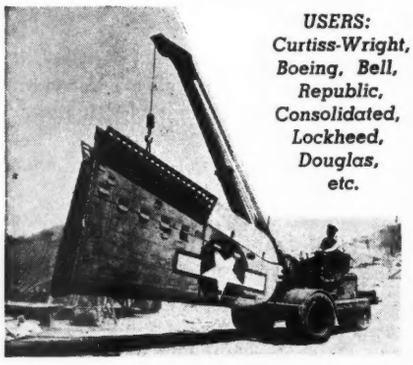
Sellstrom safeguards

Sellstrom MANUFACTURING CO.

636-10 N. ABERDEEN ST. · CHICAGO 22, ILL.

FASTER, MORE ECONOMICAL

AVIATION MATERIALS HANDLING



USERS: Curtiss-Wright, Boeing, Bell, Republic, Consolidated, Lockheed, Douglas, etc.

KRANE KAR'S fast, flexible performance speeds aviation materials handling, cuts time and labor, reduces costs. Used in airplane production . . . handling jig sections in erection and handling steel for these jig sections; unloading equipment from freight cars; loading aircraft assemblies and spare parts on cars; lifting, moving, and rearranging production equipment, raw materials, etc.; for building maintenance and repair. Write for Catalog #58.

Agents in Principal Cities

2½, 5 and 10 TON CAPACITIES

THE ORIGINAL SWING BOOM MOBILE CRANE WITH FRONT-WHEEL DRIVE AND REAR-WHEEL STEER

2½, 5, AND 10 TON CAPACITIES

KRANE KAR

TRADE MARK REGISTERED

SILENT HOIST & CRANE CO.

848-63rd ST., BROOKLYN 20, N. Y.

these replies, clearly are illuminating—

1. A total of 89.5% asked for a general air freight with limited passenger and mail accommodation direct to an aerodrome on the property; 2.6% asked for road transport; and 7.9% asked for a combination of road and rail transport, or for the cheapest transport method.

2. Moreover, a total of 91% asked for a killing and freezing center within 50 mi. of property, and 9% were doubtful.

10. **Question:** How will the airline operators contest the legislation?

Answer: Several ways are open. We can seek in the High Court a declaration that the legislation is invalid, or an injunction restraining its implementation. And again, the issues raised will permit an appeal to the Privy Council, should that be necessary.

11. **Question:** Assuming the legislation is declared valid, does its implementation follow as a matter of course?

Answer: No! The Commonwealth powers over civil aviation—as distinct from airline operation—are loaned to it by the States. The States are the guardians of the people's rights, and in view of the two referendum results, the States may adjust the position by repealing their grant of aviation power to the Commonwealth. The States, and not the Commonwealth, would then be the controllers of our civil aviation destiny.

Recent Books

(*Continued from page* 120)

purposes of trade and travel plotting and reference. This world atlas, a large and thorough volume, successfully undertakes to give the pertinent picture of the planet. In addition to the profusion of physical and political maps, there are included geographical comparison, weather, geological, lingual, agricultural, commercial, and mining maps pertaining to all phases of world economics and culture. Maps are presented in color. The volume contains a glossary of geographical terms, a gazeteer index, a self-revising feature, and a wealth of global air maps. Careful detailing is feature of the charts to simplify either state-by-state or country-by-country checking.

ARC AND ACETYLENE WELDING, by Harry Kerwin. McGraw-Hill-Whittlesey House, N. Y. C. 240 pages, photos, drawings, index. $2.50.

This volume is designed for training use of the general shop instructor or directly for the beginning student, for it leads through the step-by-step procedure in making an acetylene or electric weld. Special welding techniques are stressed, and practical methods are explained in connection with control of expansion and contraction, low-heat brazing, alloy welding, and pattern layouts.

RADIO'S MASTER. United Catalog Publishers, N. Y. C. 800 pages. $4.50.

This large book is termed the official manual and buying guide of electronic and radio equipment for all allied industries. It answers questions of radio and electronic parts, coverage being graphic and detailed. Considered are comparisons of radios and radio parts, adaptability of varied products to needs of the purchaser, the manufacturers of the products, their nearest sources, and costs.

WINGS FOR THE DRAGON, by Alice Rogers Hager. Dodd, Mead Co., N. Y. C. 307 pages. $3.

Writing from first-hand experience, the author tells the story of the air war in Asia, centering her comprehensive and fast-moving account on the CBI theater.

ELECTRONIC DICTIONARY, by Nelson M. Cooke and John Markus. McGraw-Hill Book Co., N. Y. C. 433 pages, illustrations. $5.00.

This is a comprehensive glossary containing definitions of nearly 6,500 terms used in radio, television, industrial electronics, communications, facsimile, sound recording, etc. More than 600 diagrams and sketches are included.

AIRCRAFT AND ENGINE MECHANIC'S MANUAL, by Charles A. Zweng. Pan American Navigation Service, N. Hollywood, Cal. 230 pages, drawings. $3.00.

Eleventh edition of work designed to prepare an applicant for both engine and aircraft ratings. Included are the Civil Air Regulations pertinent to the respective ratings. Procedures governing minor and major repairs are covered with complete illustrations. A new section deals with weighing procedure and C. G. location, and feature is typical multiple-choice examinations covering CAA written test.

INDUSTRIAL TRAINING AND TESTING, by Howard K. Morgan. McGraw-Hill Book Co., N. Y. C. 225 pages, tables, index. $2.50.

This work offers a new approach to this subject, giving a survey of methods and costs involved in the selection of suitable workers, showing how to test new employees, and describing a complete, workable, training organization. Methods of instruction are covered for the major divisions of industrial training, including procedure on sales, service, supervision, instruction, introductions, and also shop courses. A feature of the book is the inclusion of a complete follow-up record and evaluation system.

Aviation

Engineering Opportunities

★ ***ENGINEERS***—Mechanical and Aeronautical. To work on development and test projects. Recent engineering graduates, as well as experienced men, are needed.

★ ***DRAFTSMEN***—Detailers and Checkers.

Apply or Write to DEPT. 182

WRIGHT AERONAUTICAL CORPORATION

PATERSON 3, NEW JERSEY

MANUFACTURERS OF WRIGHT CYCLONE AIRCRAFT ENGINES

"Air Power for a World at Peace"

Another Aviation First
that includes AEROLS!
Passenger and cargo service between New York and London by land based aircraft—this significant advance in airline travel has recently been inaugurated by the American Airlines System. Flagships for these overseas flights are reliable, four-engined DC-4's which are equipped with Cleveland Pneumatic's Aerol landing gear.
At each stop, Aerols efficiently absorb the landing shock and help the plane come in safely — insuring comfort and safety for passengers and crew. Thus Aerols contribute substantially to the success of these pioneering flights.
THE CLEVELAND PNEUMATIC TOOL CO.
AIRCRAFT DIVISION • CLEVELAND 5, OHIO
AEROLS*
*PNEUMATIC-HYDRAULIC (AIR-OIL) SHOCK ABSORBING LANDING GEAR

B-29 Bomber Becomes C-97 Transport

The B-29 is unquestionably the world's finest bomber . . . its range, speed, load capacity far exceed any other. Boeing engineers and designers decided that this famous ship had peacetime possibilities as a commercial transport if its carrying capacity could be increased. So they put their heads together and came up with the C-97 . . . a double-fuselaged giant with 10,000 feet of cargo space, capable, in wartime, of transporting 100 fully-equipped troops.

Except for this new hull, the C-97 resembles its B-29 brother in most respects . . . including the tail and the huge wing with its four great Wright 2200-h.p. engines. And just as Chandler-Evans carburetors made a fine wartime record on the Superforts, so is their steady, dependable performance carrying on in this peacetime version.

As new and finer sky giants are developed in the years ahead, CECO products will continue to supply them with the precision and quality that has met the test of war.

CARBURETORS FUEL PUMPS PROTEK-PLUGS

CHANDLER-EVANS CORPORATION

WEST HARTFORD 1, CONNECTICUT

CECO

AIRTRONICS DEVELOPMENT CORPORATION

131 E. THIRD STREET • • • • • • DAYTON 2, OHIO

and its subsidiary

CHEMILECTRO CORPORATION

1330 THIRD NATIONAL BLDG. • • • DAYTON 2, OHIO

Designers and Manufacturers of electronic, plastic and mechanical devices for communications, navigation and aircraft applications.

...the appointment of

WALTER G. BOSCHEN COMPANY

NATIONAL DISTRIBUTORS AND ENGINEERS

EMPIRE STATE BUILDING • • NEW YORK 1, N. Y.

AS SOLE REPRESENTATIVES IN THE U. S. AND CANADA

and the appointment of

PAUL E. MOSS AND COMPANY

EXPORTERS AND INTERNATIONAL TRADE SUPERVISORS

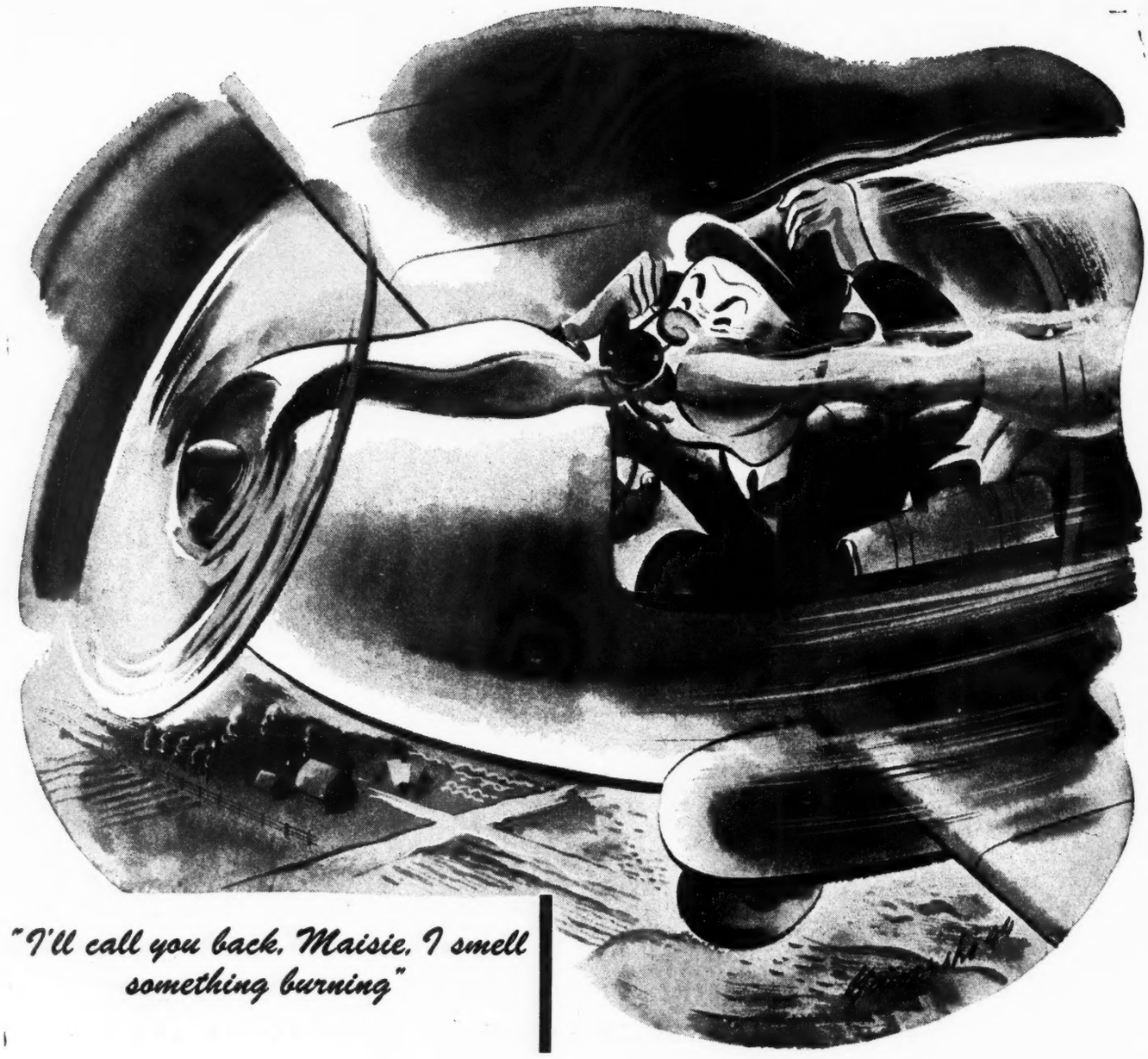
Inquiries should be directed to the address above

AIRTRONICS DEVELOPMENT CORPORATION

Look to AIRTRONICS for Outstanding, practical, new, and low-cost DEVELOPMENTS

131 EAST THIRD STREET • DAYTON 2, OHIO

AIRCRAFT CONTROL • ELECTRONICS • PLASTICS • RADIO COMMUNICATIONS • NAVIGATIONAL DEVICES



"I'll call you back, Maisie, I smell something burning"

. . . . . RADIO TO KEEP YOU SAFE AND SOUND

Let's hope that the Maisie of the above imaginary conversation never gets such an emergency call from her flying friend BUT just think how handy two-way radio communication is going to be in the flying days to come. Just think how valuable will be the Hallicrafters Skyfone—to bring you home safe and sound, to send you on your way straight and true. The Skyfone will be like all other Hallicrafters communications equipment—the finest that can be developed for the special job it will be called on to do.

hallicrafters *Skyfone*

COPYRIGHT 1945 THE HALLICRAFTERS CO.

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT • CHICAGO 16, U. S. A.

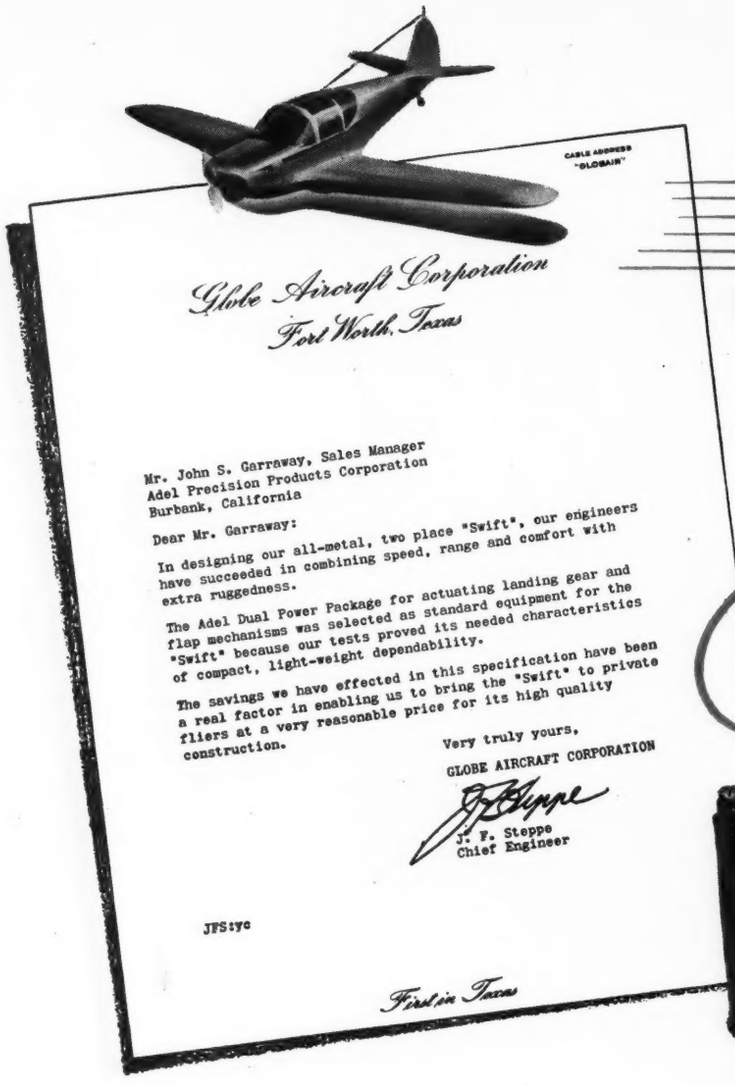
Time-honored abrasive products are now further distinguished by *a renowned name*

SIMONDS ABRASIVE CO.

For more than half a century the name Abrasive Company has been synonymous with high quality grinding wheels and abrasive products. With the years has come a tremendous increase in the use of such products and the unqualified trademark designation "Abrasive" is now inadequate as a general term to distinguish this old company. Therefore, in order to establish a more distinctive identity for the organization, a more individual crest for its quality and service, the name Simonds, renowned for over a century for excellence in cutting tools, will designate product and company.

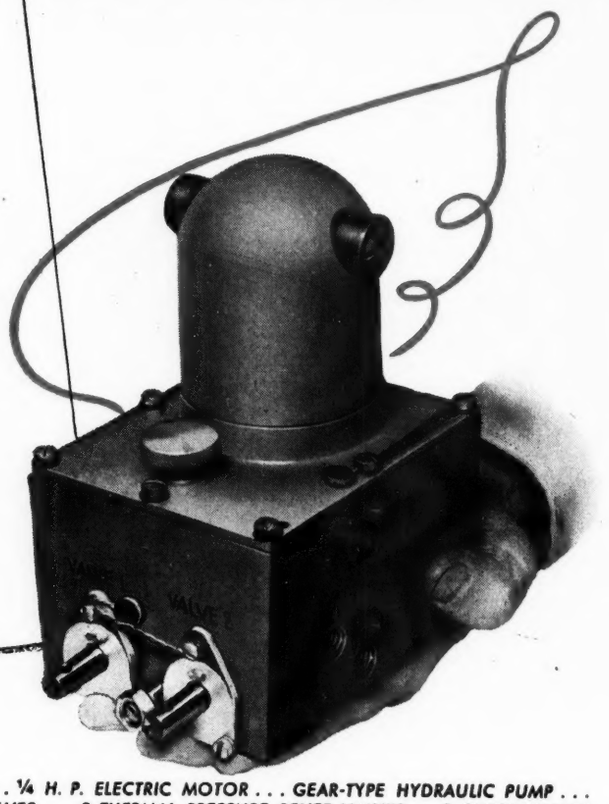
Operating under the same management and policies, SIMONDS ABRASIVE COMPANY will continue to turn out the same products of top performance which so distinguished the Abrasive Company during the past half century. SIMONDS ABRASIVE COMPANY goes forward, pledged to continue to justify the confidence of its old customers and to merit and inspire the patronage and good will of new ones.

SIMONDS ABRASIVE CO., TACONY AND FRALEY STS., PHILADELPHIA 37, PA.


CABLE ADDRESS
"GLOBAIR"
Globe Aircraft Corporation
Fort Worth, Texas
Mr. John S. Garraway, Sales Manager
Adel Precision Products Corporation
Burbank, California
Dear Mr. Garraway:
In designing our all-metal, two place "Swift", our engineers have succeeded in combining speed, range and comfort with extra ruggedness.
The Adel Dual Power Package for actuating landing gear and flap mechanisms was selected as standard equipment for the "Swift" because our tests proved its needed characteristics of compact, light-weight dependability.
The savings we have effected in this specification have been a real factor in enabling us to bring the "Swift" to private fliers at a very reasonable price for its high quality construction.
Very truly yours,
GLOBE AIRCRAFT CORPORATION
J. F. Steppe
Chief Engineer
JFS:yc
First in Texas

ADEL

HYDRAULIC DUAL POWER PACKAGE



IN ONE COMPACT UNIT . . . ¼ H. P. ELECTRIC MOTOR . . . GEAR-TYPE HYDRAULIC PUMP . . . 2 FOUR-WAY SELECTOR VALVES . . . 2 THERMAL PRESSURE RELIEF VALVES . . . 2 CHECK VALVES . . . HYDRAULIC FLUID RESERVOIR . . . BY-PASS VALVE . . . ADJUSTABLE PRESSURE RELIEF VALVE

For Actuation and Control of Light Plane Retractable Landing Gear and Flaps

ADEL PRECISION-BUILT QUALITY AND ECONOMY

Back of Adel's new Dual Power Package is an outstanding peace and wartime record of development and manufacture of hundreds of thousands of dependable hydraulic controls. Because of its amazingly simple design and the heavy flow of Adel's advanced production lines, the new Dual Power Package for light planes is surprisingly low in cost. It is a complete hydraulic system built to the same internationally respected quality and precision standards of Adel military aviation equipment . . . combat-proven on every battle front of the war.

ADEL SIMPLICITY, COMPACTNESS, LIGHT-WEIGHT

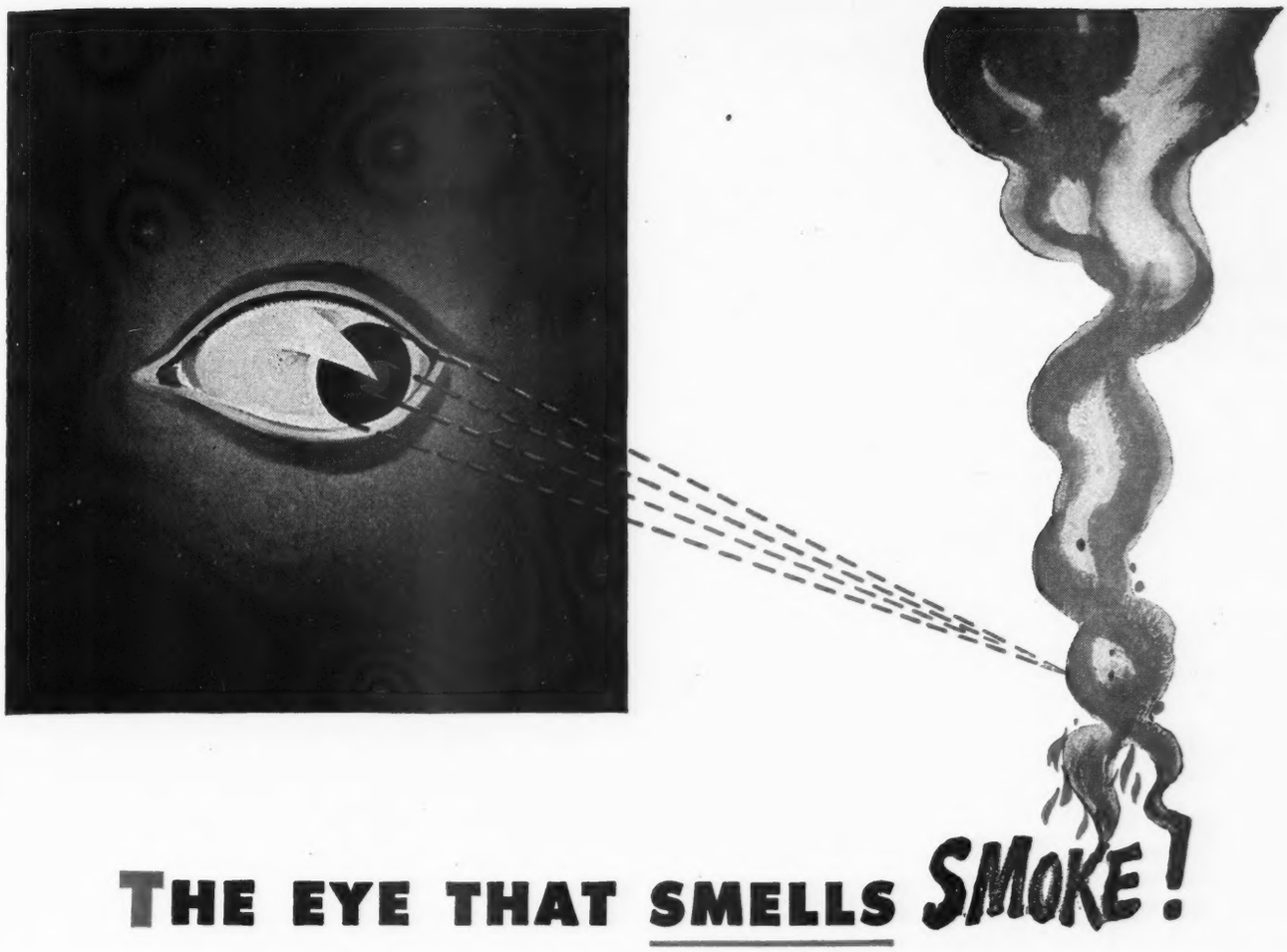
The Adel Dual Power Package is an outstanding example of Adel "design simplicity." It contains in one compact unit ***no larger than a desk phone*** an ingenious grouping of eleven hydraulic system elements. Compact, light-weight and battery operated, these elements, in combination with actuating cylinders and connecting lines, provide a complete hydraulic supply, pressure and control system.

ADEL DESIGN MEANS SAVINGS AND EXTRA DEPENDABILITY

Specified as standard equipment on light planes, the Adel Dual Power Package saves engineering and drafting expense of ordinary hydraulic or mechanical system development . . . saves in shopping and procurement of facilities and materials . . . saves elaborate assembly and installation operations . . . saves complicated cable and pulley arrangements and simplifies structural design requirements. The Dual Power Package can make possible the use of an hydraulic flap and retractable gear system heretofore regarded as prohibitive in the price range chosen for the plane. It means the utmost in dependability and long-life . . . an exceptional margin of safety . . . a literally fool-proof system instantly responsive to finger-tip control . . . free from service requirements other than periodic checks. Manufacturing plants in Burbank, California and Huntington, West Virginia. For more detailed information and prices write or wire . . .

ADEL
PRECISION PRODUCTS CORPORATION

ADEL PRECISION PRODUCTS CORPORATION • 10523 VAN OWEN ST., BURBANK, CALIF.



THE EYE THAT SMELLS SMOKE!

A puff of smoke in the baggage compartment:::

The Kidde Smoke Detector instantly gives the alarm!

Smoke from the airflow is drawn into the path of a light beam. An electric eye—constantly scanning the beam...spots the change in light intensity. Warning is flashed to the pilot *at once.* One blast from a portable extinguisher—and the fire is out.

But...a dip in voltage dims the light. Will the electric eye mistake this for smoke—give a false alarm?

Not with the Kidde Smoke Detector!

There's a *second* photoelectric cell focused on the light source. And the space between is sealed against smoke. When the light source dims, *both* cells react...the relay connected to them stays in balance. Result: no alarm. *Only* smoke can actuate the Detector!

The Smoke Detector is one of the newest contributions of Kidde skill to safe air transportation. Plane manufacturers and transport companies are invited to write to Kidde for full information.

Walter Kidde & Company, Inc., 118 Main Street, Belleville 9, New Jersey

Kidde

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

Exide AIRCRAFT BATTERY SUPPLY AND SERVICE

COVER THE COUNTRY FROM COAST TO COAST

Airport service operators can get Exide Aircraft Batteries and related supplies at conveniently located points along air routes and on or near air terminals from Exide Aircraft Battery Wholesale Distributors. These long established organizations are the leaders in the field of aviation parts distribution. They are ready to render prompt and complete service to meet all your replacement battery needs. Get in touch with the nearest Exide Distributor.

CALIFORNIA

Burbank
Pacific Airmotive Division
Lockheed Air Terminal

Glendale
Pacific Airmotive Division
Airplane Mfg. & Supply Corp.
6265 San Fernando Rd. (1)

Los Angeles
Air Associates, Inc.
Airport & Century Blvds. (43)

Oakland
Pacific Airmotive Division
Oakland Airport (3)

San Diego
Pacific Airmotive Division
544 Seventh Ave. (1)

COLORADO

Denver
Snyder Aircraft Corporation
1525 Broadway (2)

FLORIDA

Miami
Aviation Supply Corporation
3030 Coral Way (35)

Orlando
Aviation Supply Corporation
Cannon Mills Airport
P.O. Box 193

GEORGIA

Hapeville—Atlanta
Aviation Supply Corporation
Atlanta Municipal Airport
P.O. Box 512

ILLINOIS

Chicago
Air Associates, Inc.
5300 W. 63rd St. (38)

Chicago
Snyder Aircraft Corporation
5036 W. 63rd St.

MASSACHUSETTS

East Boston
Intercity Aviation, Inc.
Logan Airport (28)

MICHIGAN

Detroit
General Aircraft Supply Corporation
Detroit City Airport (5)

MINNESOTA

Minneapolis
Van Dusen Aircraft Supplies
2004 Lyndale Ave. S. (5)

MISSOURI

Kansas City
Pacific Airmotive Division
1628 McGee St. (8)

Robertson
Supply Division, Inc.
Lambert Airport

NEBRASKA

Omaha
Snyder Aircraft Corporation
Municipal Airport (2)

NEW JERSEY

Teterboro
Air Associates, Inc.

NEW YORK

Flushing
Durham Aircraft Service, Inc.
North Boulevard at Prince Street

NORTH CAROLINA

Charlotte
Aviation Supply Corporation
330 N. Tryom St. (2)

OHIO

Cleveland
General Airmotive Corporation
Cleveland Municipal Airport
Rocky River Drive (11)

Columbus
Snyder Aircraft Corporation
Sullivant Ave. Airport (4)

OKLAHOMA

Oklahoma City
Supply Division, Inc.
108 West Grand Ave. (2)

OREGON

Portland
A. W. Whitaker
5001 Union Ave., N. E.

PENNSYLVANIA

Pittsburgh
Bob Trader Aero Supply
929 Penn Ave. (22)

TENNESSEE

Memphis
Supply Division, Inc.
229 Memphis St. (3)

Nashville
Aviation Supply Corporation
905 Church St. (3)

TEXAS

Dallas
Air Associates, Inc.
Love Field (9)

San Antonio
The W. B. Matthews Co.
201 E. Grayson St. (2)

WASHINGTON

Kent
Pacific Airmotive Division
P.O. Box 272

Seattle
Northwest Air Service, Inc.
Boeing Field (8)

ALASKA

Anchorage
Pacific Airmotive Division
P.O. Box 320
Merrill Field

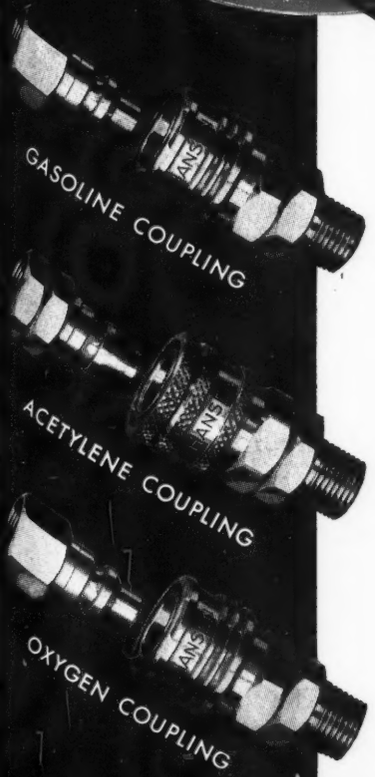
Fairbanks
Northwest Air Service, Inc.

Exide
AIRCRAFT
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto

GLOBALLY USED!

HANSEN COUPLINGS



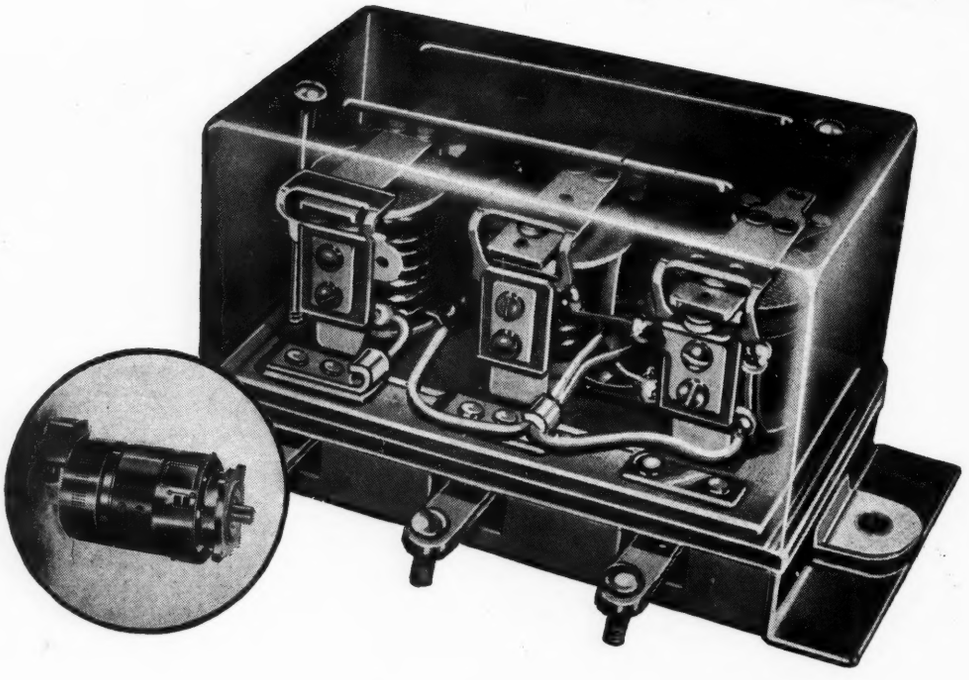
THERE ARE DEFINITE REASONS for the world wide popularity of Hansen couplings.

Performance is what put them on top and this same remarkable performance is what is keeping them there. Make no mistake about this — no coupling on the market has the all 'round advantages of Hansen Coupling's. In buying, sound decisions rest on facts, check over these facts on Hansen Push Tite coupling before purchasing any coupling. It is compact, sturdy with all moving parts protected—it will and can take rough going. Its remarkable ABC simplicity in operation is unique. Simply push plug into socket, it is connected, air is automatically turned on. To disconnect merely slide sleeve back with thumb, it is disconnected and air is automatically turned off. No twisting or turning to connect or disconnect, no kinking of hose due to swivel action. It will take pressures as low as a couple of ounces up to a peak of over 10,000 pounds without leaking. No other coupling can match these features. There's a Hansen coupling made for air, oil, grease, oxygen, gasoline and acetylene and they come in a wide range of sizes. • • • Send for free industrial catalogs.

THE HANSEN MFG. COMPANY

1786 EAST 27th STREET • CLEVELAND 14, OHIO

NEW *for Heavy Duty Service—*



A VOLTAGE REGULATOR

of famous Leece-Neville Quality

HERE'S VITAL NEWS for all users of aircraft electrical equipment—a new heavy duty voltage regulator of quality construction—*famous Leece-Neville quality*. Of double-contact design based on Leece-Neville patents, this new 3-element, 12 volt regulator is rated up to 50 amperes. That means it will control generator output *in excess* of currents generally encountered! For replacement or original equipment here's the natural heavy duty companion of the Leece-Neville aircraft generator, types E5A or E7A (12 volts, 50 amperes). But remember: *wherever* ordinary regulators give trouble, this extra-capacity regulator should provide the answer to your problem. Write today for bulletin giving complete information. *The Leece-Neville Co., Cleveland 14, Ohio.*

LEECE-NEVILLE

Pioneer and STILL Quality Leader

GENERATORS • VOLTAGE REGULATORS • SWITCH RELAYS • PUMP MOTORS

WHEN THE NC-4 CROSSED THE ATLANTIC

WOLF'S HEAD WAS FORTY YEARS OLD

In 1919 when the United States Navy NC-4 completed the first transatlantic flight in Aviation history, Wolf's Head had already completed 40 years in the business of refining quality oils.

During the first World War aviation made tremendous strides, but it was destined to make more phenomenal advances in the years following. Having kept pace with aircraft engine development during World War I, Wolf's Head foresaw the potential growth of Aviation.

Years of refining experience and a wealth of research enabled Wolf's Head to match each step forward in aircraft engine development. Today, Wolf's Head Aviation Oil is of such high quality that leading aircraft engine manufacturers have specified it for critical break-in and test runs.

Whatever design will be developed for planes of the future, Wolf's Head Aviation Oil will keep pace with the "pace-setters of Aviation."

WOLF'S HEAD OIL REFINING COMPANY, INC.
OIL CITY, PA., or NEW YORK 10, N. Y.

WOLF'S HEAD

100% PENNSYLVANIA

AVIATION OIL

P.G.C.O.A. Permit No. 6

WOOL FELT... Mechanical functions fulfilled by this non-structural engineering material

FILTRATION

1. Filtration ✓	7. Shock-absorbing
2. Polishing	8. Cushioning
3. Sealing	9. Padding
4. Wicking	10. Packaging
5. Vibration Isolation	11. Surfacing
6. Sound Absorption & Thermal Insulation	12. Frictional

The radial fin element of all Protectomotor Industrial Filters is Feltex, a special Felt designed by Staynew Filter Corporation and American Felt Company engineers. Photo shows elements before and after use in needle control valve of a pneumatic tool.

Because of versatile blend and distribution of selected fibres, Felt filters are characterized by slow plugging rates and high retention efficiency. Adapted to both gravity and pressure equipment, they are used for filtering electro-plating solutions, solvents, paints, lacquers and oils.

Felt's non-reactive tendencies enable it to be used in filtering photographic emulsions, nutrient broths and fruit syrups. Capable of sterilization, it has a unique surgical application in intravenous feeding sets for blood transfusions.

Widely used in respirators, air conditioning and industrial dust, fume and mist filters, it has a tested efficiency in excess of 99 per cent by weight in the removal of 0.5 micron mean diameter lead fume particles from air.

When figuring any filtering problem, an American Felt Company engineer — experienced in filter design — is available for helpful counsel. Please get in touch with our nearest office.

American Felt Company
TRADE MARK

General Offices: GLENVILLE, CONN.

New York, Boston, Chicago, Detroit, Philadelphia, Cleveland, St. Louis, San Francisco, Dallas, Seattle, Los Angeles, Atlanta

PRODUCERS OF FINEST QUALITY FELT PARTS FOR OIL RETAINERS, WICKS, GREASE RETAINERS, DUST EXCLUDERS, GASKETS, PACKING, VIBRATION ISOLATION, INSULATION AND SOUND ABSORPTION FELTS

Kester has the RIGHT FLUX for Every Solder Job

• You can always get the right flux, from Kester.... a flux you *know* will properly clean, prevent oxidation, make way for a tight bond that will resist shock, vibration or bending as desired, and eliminate soldering failures.

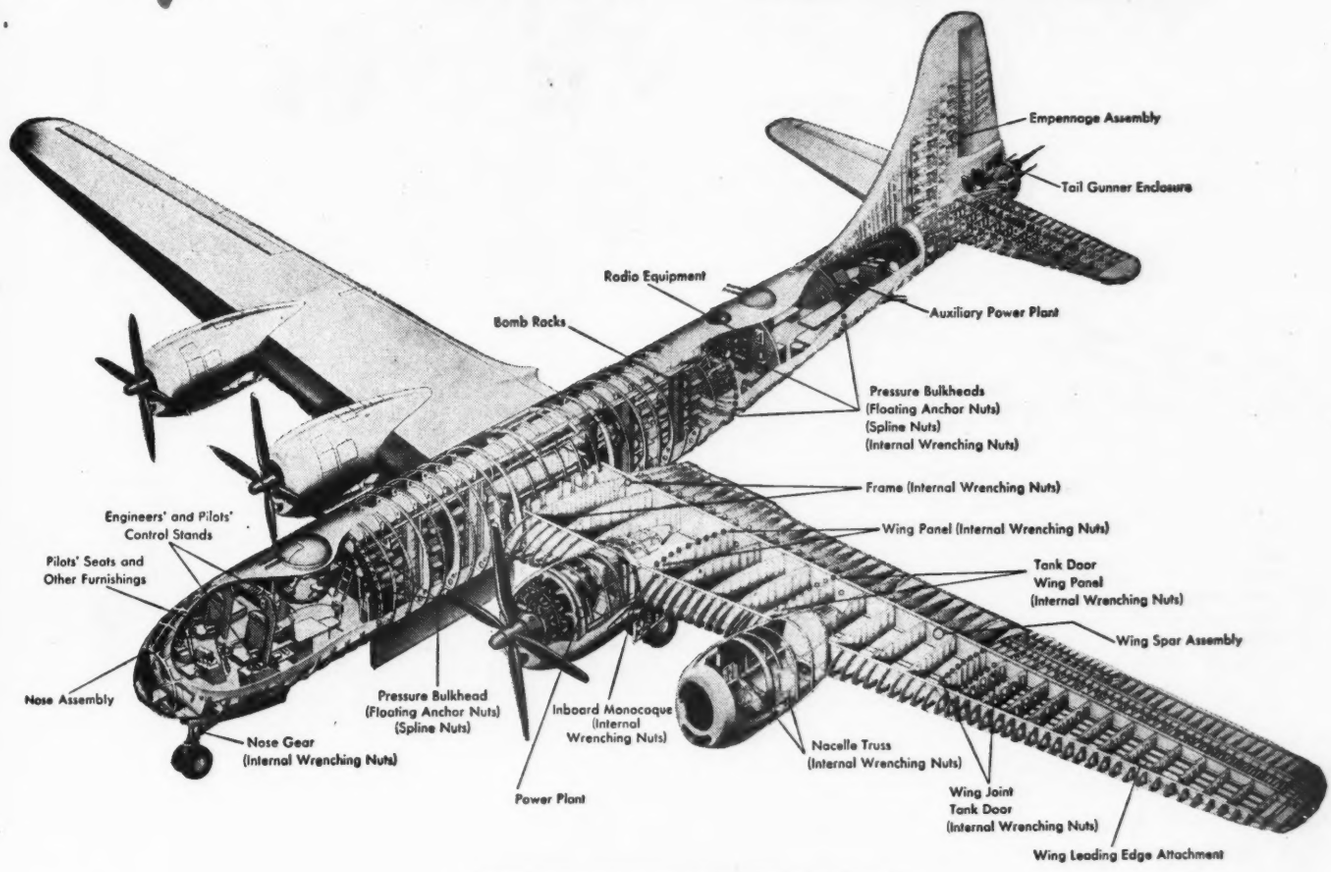
• During Kester's 47 years of experience, hundreds of Kester flux formulas have been time-tested in laboratory and industry, to establish exact specifications for every flux need. Among them is the ideal flux formula for you.

• Write us, and Kester engineers will consult with you, without obligation.

KESTER SOLDER COMPANY
4206 Wrightwood Ave., Chicago 39, Illinois
Eastern Plant: Newark, N. J.
Canadian Plant: Brantford, Ont.

KESTER
Solder Fluxes
STANDARD FOR INDUSTRY

"Inside story" OF THE B-29



SEVENTY-FIVE THOUSAND ELASTIC STOP NUTS

With military censorship now lifted, there's an important inside story that can be told.

From nose to tail, from wingtip to wingtip, there are 75,000 red-collar nuts in a single Boeing B-29 Superfortress. Seventy-five thousand Elastic Self-Locking Stop Nuts!

They spread stresses throughout the skin structure, as some day soon they will on automobiles, railroad cars, buses. They hold fast such heavy parts as engines and auxiliary equipment, as they will in tractors, trucks, industrial machinery. They assure tight connections in the electrical equipment of this "all-electric" plane, as they will in postwar home radios, sewing machines, vacuum cleaners. They grip firmly on wheels, axles, structural framing, as they will on harvesters, combines, cultivators and other farm equipment.

It's hopeless to try to show 75,000 of these Elastic Self-Locking Stop Nuts in the drawing above—just as it's hopeless to try to list all the applications where these red-collar nuts can help you achieve higher production and a more dependable product.

Let us send an ESNA engineer to confer with you and outline a solution for any fastening problems you may have.

LOOK FOR THE RED COLLAR
THE SYMBOL OF SECURITY

LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.
THE COLLAR IS ELASTIC. THE NUT CAN BE USED TIME AND TIME AGAIN
MADE IN ALL SIZES AND TYPES — WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.

ESNA
TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA
Union, N. J.

* ① Torque it!

It has unequalled torsional strength

** ② Push or Pull it!

It has unmatched tensile and compression strengths

*** ③ Run it under load!

It outlasts any conventional joint, withstands the most adverse operating conditions

Facts

demonstrate beyond question that Apex Heavy Duty Universal Joints are stronger, lighter, will outperform and outlast any joint you can buy.

The Reasons: Apex exclusive design balances the strength of the yokes, block, and pins to provide greater static and operating torque, highest shock load capacity, lowest deflection and maximum freedom from binding under overload. Apex exclusive cover (optional) seals lubricant in, seals foreign matter out, dampens vibration, minimizing fatigue and wear. More: it permits running Apex joints in corrosive or dust-laden atmosphere, in water, caustics, acids, etc. Apex joints won't throw oil, will not freeze at minus 75°F. nor fail at plus 250° F. Sizes: 3/8 to 1 1/2". Style of barrels: you name it. Write for Apex Joint "Data Rule."

Nominal size (inches)	* ① Static torque (inch-lbs.)	** ② Axial ten. & compres. (lbs.)	*** ③ Recommended operating torque (inch-lbs.)
3/8	275	550	41
1/2	600	1000	90
5/8	1080	1500	162
3/4	2200	2000	330
7/8	3500	2500	525
1	5000	3000	750
1 1/4	10,000	4500	1500
1 1/2	14,500	6000	2175

APEX

Aircraft Universal Joints

THE APEX MACHINE & TOOL COMPANY • DAYTON 2, OHIO

Exclusive Licensee Under F. & S. Joint Patents

When History Repeats Itself....

Hannibal can sell his elephants to the zoo and *FLY* the Alps

The way they tell it, Hannibal had quite a time getting his army over the Alps back in 218 B. C. He finally made it, after a tough winter, using elephants for troop and cargo transportation, and eventually sneaked down into the valley to give Scipio a good trouncing. Next time, in hours instead of months, he can *fly* his army over in fast dependable ships like the Lockheed Constellation . . . and never mind the ponderous pachyderms.

New history in air travel and air trade is ready for the writing. An important factor in making planes of all types lighter and stronger is, has been and will be OSTUCO Steel Tubing in such vitals as engine mounts, strut assemblies, fuselage frames and hydraulic systems. The *trust* which every major plane manufacturer places in this company is based on skill, experience and high quality standards which are traditionally OSTUCO's . . . from the earliest days of tube making in America.

THE OHIO SEAMLESS TUBE COMPANY

OSTUCO — SHELBY OHIO

BRANCHES: 20 N. Wacker Drive, Chicago; 1328 Citizens' Bldg., Cleveland; 2857 E. Grand Blvd., Detroit; 927a M&M Bldg., Houston; 170 S. Beverly Drive, Beverly Hills (Los Angeles); 225 5th Ave. Bldg., Moline; 3735 St. James St., Montreal; 70 E. 45th St., New York; 123 S. Broad St., Philadelphia; 1230 N. Main St., St. Louis; 1911 Smith Tower, Seattle; 501 Roberts Ave., Syracuse; 604 Tulsa Loan Bldg., Tulsa; 1016 Mainland St., Vancouver.

Plant and Main Office
SHELBY, OHIO

MANUFACTURERS OF SEAMLESS AND ELECTRIC-WELD STEEL TUBING

FOR DURABILITY THAT MEANS ECONOMY IN UNIFORMS — *DEMAND*

REEVES ARMY TWILL

"FROM COTTON TO CUTTER"

Over 90 million yards of Reeves Army Twill helped equip America's fighting men—exceeding Government specifications under the toughest climatic and combat conditions. Now you can specify this same durable smart looking fabric for uniforms and work clothes. Its high tensile strength insures rugged wearability. It tailors smartly, too, and is color-fast to sun, water and perspiration. Sanforized Shrunk*, it is the fabric for long-lasting economy. Demand uniforms and work clothes bearing the Reeves Army Twill label.

**Residual shrinkage less than 1%*

THE REEVES FABRIC GROUP INCLUDES: *Reeves Army Twill*
Glengarrie Poplin • Reeveking Gabardine • Byrd Cloth
Marine Herringbone • Mountain Cloth • Warrior Twill

SPINNING WEAVING DYEING FINISHING Reeves FABRIC

Mills Mill, Greenville, S. C. and Woodruff, S. C.
Fairforest Finishing Co., Spartanburg, S. C.

REEVES BROTHERS, INC.
54 WORTH STREET • NEW YORK 13, N. Y.

Representatives in Atlanta • Boston • Chicago • Dallas • Los Angeles • Philadelphia • St. Louis • Montreal • Toronto

How up-To-Date are you on ALUMINUM?

A Complete Integrated Service on Aluminum Forms

REYNOLDS

PRODUCTS	INFORMATION
SHEET AND PLATE	BULLETIN 22-A
WIRE, ROD AND BAR	BULLETIN 31-A
TUBING AND PIPE	BULLETIN 17-B
EXTRUDED SHAPES	BULLETIN 35-A
FORGING STOCK	BULLETIN 23-A
ALUMINUM COATINGS	BULLETIN 21-B

✓ Check, Fill out, MAIL TODAY!

22-A
31-A
17-B
35-A
23-A
21-B
100-A

Reynolds Metals Company, Aluminum Division
2536 South Third Street, Louisville 1, Kentucky

Please send me literature checked (✓) in the spaces above.

Name_____

Title_____

Street_____

City & Zone_____ State_____

What alloy? What temper? What form? Ask us!

Back from the war, covered with glory, aluminum is the public's fair-haired boy. Everyone knows about it, talks about its light weight, its great strength, yet many engineers may not realize the vast number of combinations available today—the alloys, the tempers, the forms . . . *the great importance of careful selection!*

Use coupon at the right for complete information on each form. Or phone nearest office. Reynolds Metals Company, Aluminum Division, 2536 South Third Street, Louisville 1, Kentucky.

For Designers and Engineers—Catalog 100-A

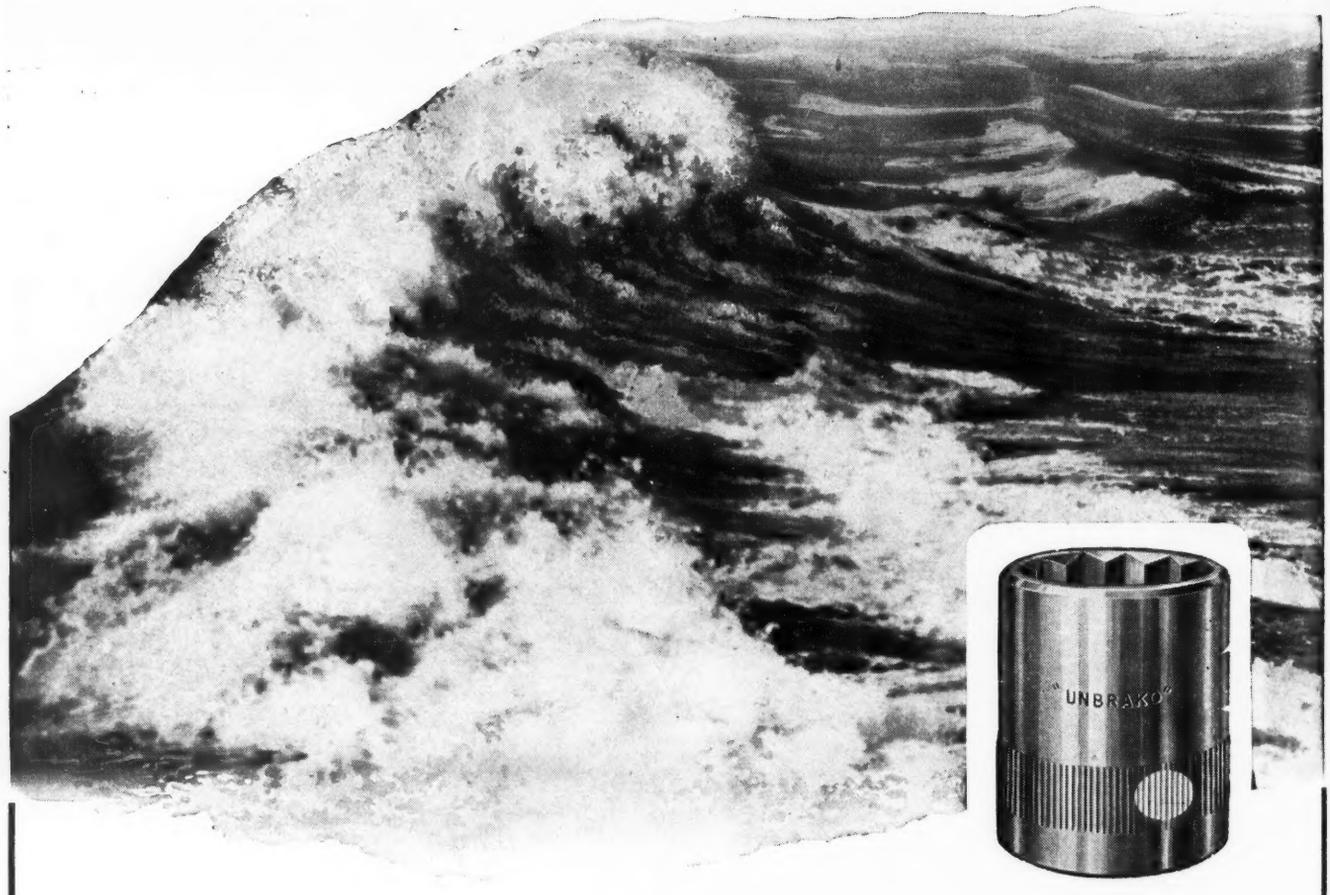
CONSIDER ALUMINUM . . . CONSULT REYNOLDS

REYNOLDS METALS

REYNOLDS ALUMINUM

The Great New Source of

INGOT • SHEET • SHAPES • WIRE • ROD • BAR • TUBING • PAINTS • FORGINGS • CASTINGS • FOIL • POWDER



As Reliable as the Tides...

As the tides can be relied upon to rise and fall with mathematical certainty, . . . so the "Unbrako" Internal Wrenching Lock Nut can be relied upon for precise, dependable performance.

Heat-treated to a high degree of Rockwell hardness, it can be used again and again, before the torque falls below the Wright Field minimum.

An officially approved safety nut for primary connections in aircraft, the "Unbrako" Lock Nut is made with extreme care. The locking feature is provided by two vulcanized fibre plugs (Fig. 1), inserted through the body of the nut. These plugs contact four threads of the bolt, assuring an absolutely dependable locking grip . . . as reliable as the tides!

Fig. 1

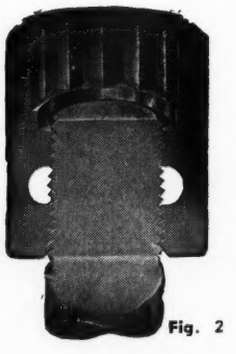


Fig. 2

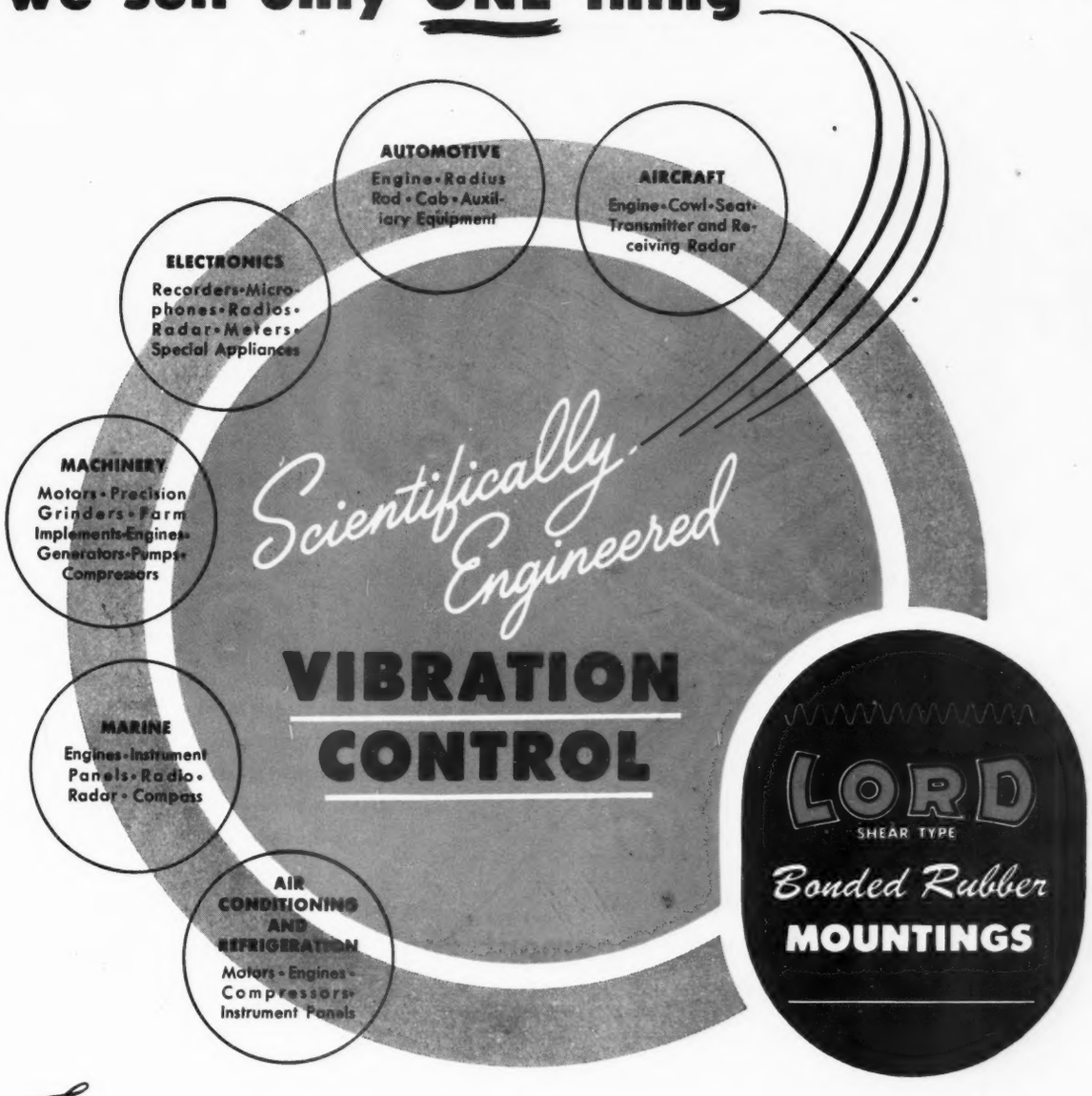
OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 566

BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • SAN FRANCISCO • ST. LOUIS

we sell only ONE thing


AUTOMOTIVE
Engine • Radius Rod • Cab • Auxiliary Equipment
AIRCRAFT
Engine • Cowl • Seat • Transmitter and Receiving Radar
ELECTRONICS
Recorders • Microphones • Radios • Radar • Meters • Special Appliances
MACHINERY
Motors • Precision Grinders • Farm Implements • Engines • Generators • Pumps • Compressors
MARINE
Engines • Instrument Panels • Radio • Radar • Compass
AIR CONDITIONING AND REFRIGERATION
Motors • Engines • Compressors • Instrument Panels
Scientifically Engineered
VIBRATION CONTROL
LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

FOR twenty-five years Lord has pioneered the science of vibration control and isolation. We studied vibration, wherever we found it—vibration caused by regular or intermittent shock, by rotating parts, by impact, by concussion, by sound waves, by irregular and accidental shock.

What we have to sell is relief from vibration—relief from its wear and tear on machines and men, relief from its attacks on quality and quantity of production, relief from its interference with proper functioning of delicate instruments, and sound transmitting and receiving apparatus.

Our research and experience proved that rubber, bonded to metal, used as the absorbing element, if correctly designed, as to shape and size, stressed in free shear at predetermined deflections for specific applications, is superior to any other material because it combines almost unlimited controllability, with great elasticity.

Today we use rubber, natural and synthetic, of many stiffnesses; we use steel, we use brass, monel, dural. But we're not selling any of these—we're selling precision engineered vibration control and isolation.

The most important ingredient of any Lord Mounting you buy is—brains. You can't buy them, either, except as they are embodied in the assured protection you buy when you make sure that the name LORD is stamped or molded in the product.

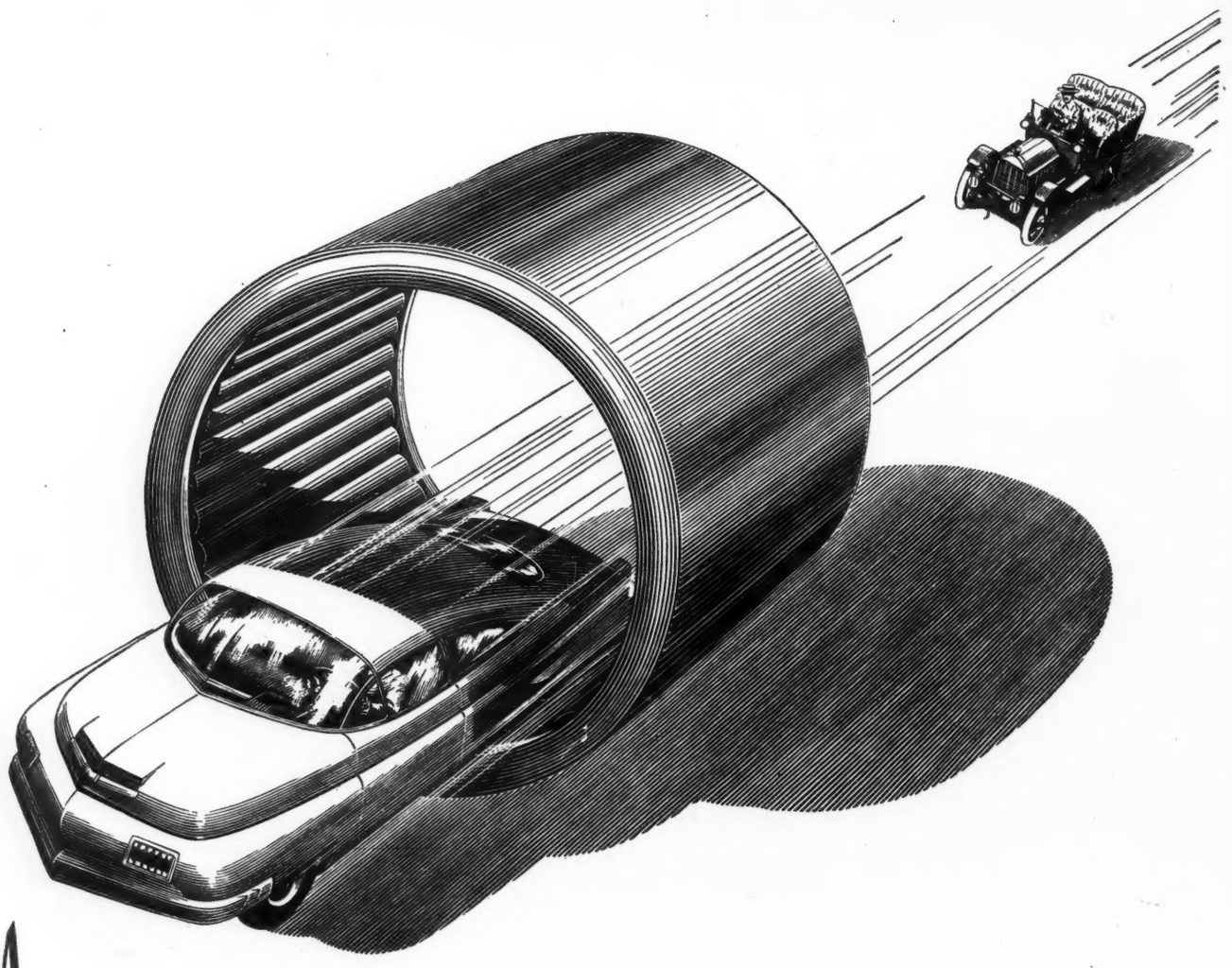
IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

★
BUY VICTORY BONDS
★

Originators of Shear Type Bonded Rubber Mountings



Another Engineering Advancement that is Bringing Down Costs

Engineering methods and materials have come a long way since those days in the 'twenties when the "medium priced car" sold at $3,000. And each subsequent engineering advancement has contributed to better performance at lower cost.

That's what Torrington Needle Bearings are doing—*by providing anti-friction advantages and lowering costs all along the line...*

First costs are low because Needle Bearings are adaptable to precision production at low unit cost.

Assembly and housing costs are low: the bearing's unit construction facilitates handling and speeds assembly; and only the simplest housing is required—a bore machined to proper dimensions.

And "last cost" is low: for the high capacity and efficient lubrication of Torrington Needle Bearings insure long service life. Needle Bearings never seem to wear out or require replacement.

If you are seeking improved performance at lower cost and are not fully aware of the possibilities of Needle Bearings, send for our Catalog No. 32 which gives a comprehensive picture of their many advantages.

THE TORRINGTON COMPANY
TORRINGTON, CONN. • SOUTH BEND 21, IND.
Offices in All Principal Cities

TORRINGTON NEEDLE BEARINGS

NEW PROBLEMS?

C-D has acquired the

KNOW-HOW

to help you apply

INDUSTRIAL MOLDED PLASTICS

C-D technicians will help you successfully apply industrial molded plastics to your specific design and production problems. Available to you is the KNOW-HOW acquired in helping solve thousands of "What Material?" problems, by the successful application of C-D CELORON . . . a molded fabric plastic.

The unit illustrated herewith is a two piece CELORON molded macerated fabric insulating casing used in U. S. Navy equipment. Mechanical strength,dimensional stability, and thermal insulating properties, as well as electrical insulating properties were needed to meet the requirements of the service in which it is used.

Solving such problems is the every day job of C-D technicians. You will save time and worry . . . and avoid product failure . . . by consulting with C-D technicians when your products are in the blue print stage.

Wire, phone, or write the nearest C-D office . . . and a C-D technician will get on the job.

C-D PRODUCTS

The Plastics

DILECTO—Thermosetting Laminates.

CELORON—A Molded Phenolic.

DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.

HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE

VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

Descriptive Literature

Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

Continental-Diamond

C-D

Engineered Molded Plastics

REC—46

BRANCH OFFICES

NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES

WEST COAST REPRESENTATIVES: MARWOOD LTD., SAN FRANCISCO 3

IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

SEE OUR CATALOG IN SWEET'S

Millions of UNIBAL BEARINGS

HEIM

During the War, literally millions of Heim Unibal spherical bearings and rod ends were used in airplane construction for the Army and Navy. They proved themselves rugged under the most severe conditions.

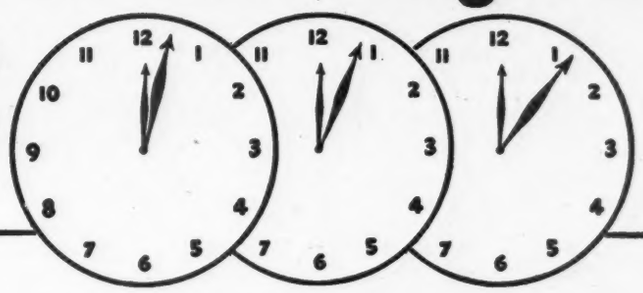
Constructed of an outer ring in any size to fit your particular requirements, bronze inserts inside the ring, and a hardened chrome steel ball with large area contact, this new Heim Unibal bearing paves the way for entirely new applications where radial and axial loads are too heavy for the conventional type of bearing.

If allowances for misalignment must be made in any direction, the Heim Unibal bearing is your answer.

Write for illustrated catalog.

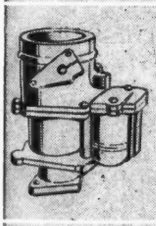
THE HEIM COMPANY
FAIRFIELD CONNECTICUT

How to Cut Metal Cleaning Time to MINUTES



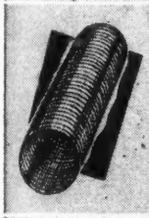
NEW, FAST-ACTION DETERGENT CLEANS FERROUS AND NON-FERROUS METALS...Easy to Handle

TYPICAL USES FOR Solvent "26"



CARBURETORS—Solvent "26" removes gum, gasolene sediment and other accumulations of dirt.

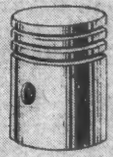
SPARK PLUGS—Solvent "26" safely cleans porcelain; helps loosen carbon deposits.



METAL PLATES AND SCREENS—Solvent "26" restores clear, clean finish to any metal surface.

DIES AND STAMPING—Solvent "26" removes drawing compounds from die-formed or stamped metal.

LABORATORY EQUIPMENT—Solvent "26" frees glass and metal tubing and their supports of gums, varnishes and other incrustations or deposits.



PISTONS—Removes lacquers, gums, resins, etc. from gas, gasolene and diesel engine pistons and rings. Also effective for cleaning all parts of dismantled motors, engines and machinery.

REMOVES:

Oil • Grease • Gums • Varnishes • Lacquers • Paints
Carbonaceous Deposits • Asphaltic Products

FROM:

Steel • Cast Iron • Aluminum • Porcelain • China
Chrome and Nickel Plate • Stone • Precious Metals
Brass • Washable Fabrics

Used throughout the war in critical industry as a superior cleaning agent, newly-developed SOLVENT "26" is now available for all industrial needs.

Offering many advantages in time, labor and cost over other present cleaning methods . . . Solvent "26" is so effective a detergent it can be used at *ordinary* room temperatures.

The fast action of Solvent "26" reduces cleaning time from hours to minutes on dismantled engine parts and all kinds of machinery. Simply dip, rub, brush or spray it on. Then flush clean with hot water.

Mail the coupon today for literature and information leading to a demonstration of this unique product in your own plant.

CITIES SERVICE OIL COMPANY
ARKANSAS FUEL OIL COMPANY

CITIES SERVICE OILS
ONCE-ALWAYS

Cities Service Oil Company
Room 552
70 Pine Street
New York 5, N. Y.

Gentlemen: I am interested in a demonstration of Solvent "26"—at no cost or obligation.

Name.....

Title.....

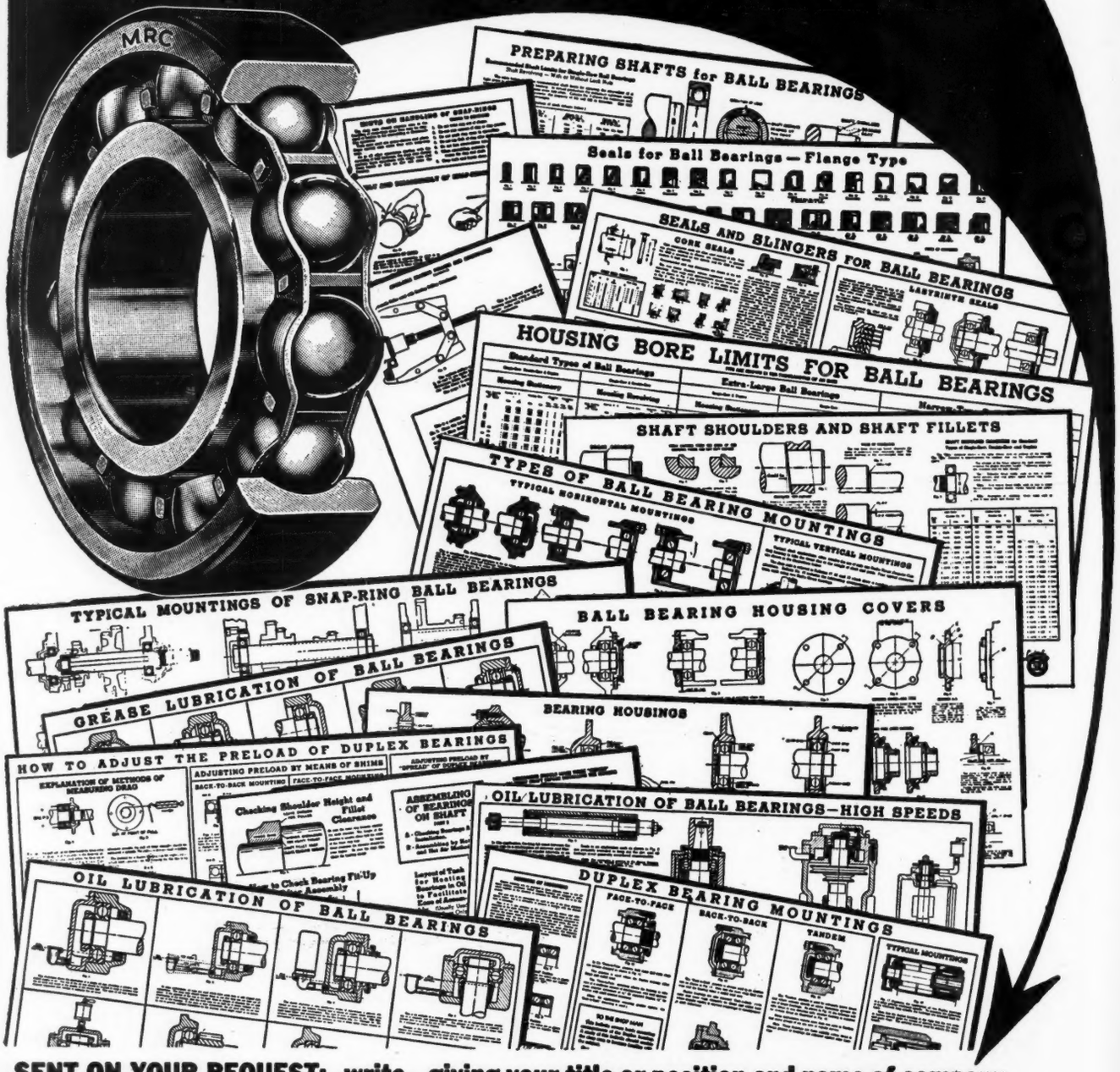
Company.....

Address.....

City.....State.....

27 BULLETINS on

Ball Bearings—their installation, use and maintenance. Available to shop men, maintenance men, engineers, designers and draftsmen.


MRC
PREPARING SHAFTS for BALL BEARINGS
Seals for Ball Bearings—Flange Type
SEALS AND SLINGERS FOR BALL BEARINGS
HOUSING BORE LIMITS FOR BALL BEARINGS
SHAFT SHOULDERS AND SHAFT FILLETS
TYPES OF BALL BEARING MOUNTINGS
TYPICAL MOUNTINGS OF SNAP-RING BALL BEARINGS
BALL BEARING HOUSING COVERS
GREASE LUBRICATION OF BALL BEARINGS
BEARING HOUSINGS
HOW TO ADJUST THE PRELOAD OF DUPLEX BEARINGS
OIL LUBRICATION OF BALL BEARINGS—HIGH SPEEDS
OIL LUBRICATION OF BALL BEARINGS
DUPLEX BEARING MOUNTINGS

SENT ON YOUR REQUEST; write, giving your title or position and name of company.

M-R-C BALL BEARINGS

MARLIN-ROCKWELL CORPORATION

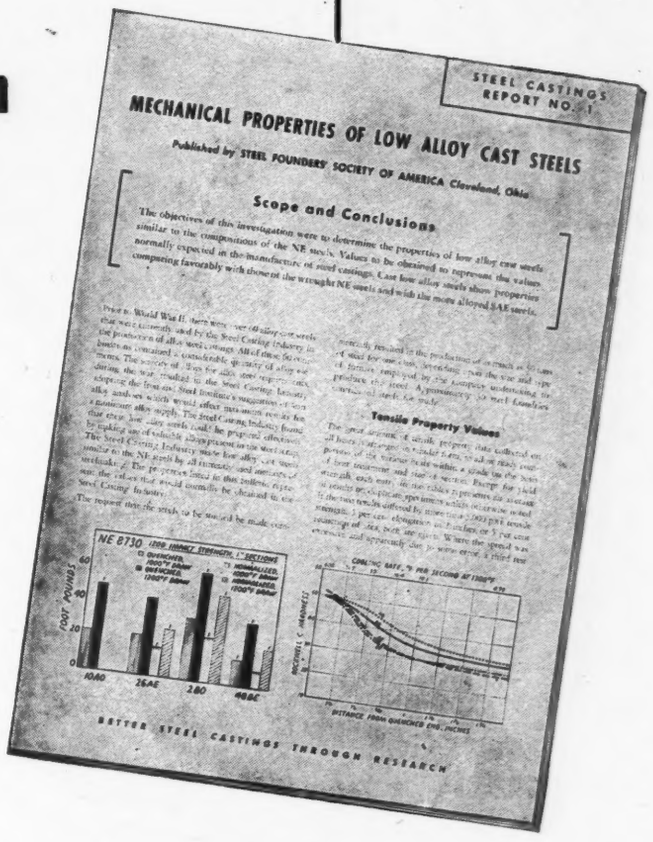
Executive Offices: JAMESTOWN, N. Y.

Do You Want to get — *Regularly* — the Latest Information on STEEL CASTINGS?

The Steel Founders' Society, through its Technical and Research Department, has been carrying on an organized research program, in cooperation with leading universities and industrial laboratories.

The results of this research program will be published in a series of bulletins, as a service to the users of steel castings.

Copies of the reports will be sent you as published. There will be no charge or obligation. Just fill out and mail the coupon below.



Subjects

to be covered will include the latest data on the Metallurgical Properties, Specifications and Heat Treatment of Cast Steels, and useful engineering information on Steel Castings.

Send this coupon to

STEEL FOUNDERS' SOCIETY
920 Midland Bldg.
Cleveland 15, Ohio

Your Name .....
Your Position .....
Your Company .....
Street .....
City ..... **Zone** ..... **State** .....
Principal Products .....

There is no obligation when you mail this coupon AV

UNITED STATES ELECTRICAL TOOLS

will help you glide into your 1946 programs with ease and every assurance of better and more economical production.

These famous tools are better than ever . . . . embodying the experience gained since 1897 PLUS the lessons learned "the hard way" during the war years.

LOOK TO UNITED STATES ELECTRICAL TOOLS TO HELP YOU CUT COSTS AND INCREASE PRODUCTION IN '46.

SPECIAL ¼" HEAVY DUTY AVIATION DRILLS

Note the many features:

Motor: Universal

Speed: to meet your requirements from 700 to 5,000 r.p.m.

Bearings: ball-bearing throughout, set in steel retainers. Screw plugs to permit easy replacement.

Switch: with locking pin in center of trigger, near the end. Can be used by right-hand or left-hand operator.

Cable: 15 ft. 3-wire with special rubber type protector in handle of drill. One wire for grounding drill.

Chuck: 3-jaw type, screwed on to spindle with right-hand threads.

Ample clearance between field laminations and motor housing to provide a free flow of air. A baffle plate is mounted in the motor housing and is so constructed that air must pass around the fields and over the armature thus preventing overheating.

The rear cap over commutator is held in place by two small screws and can be removed easily for quick commutator inspection, replacement of brushes or adjustment of brush holders.

MODEL ARS
¼"
WEIGHT 3¾ LBS. 7½" LONG

WRITE FOR FULL DETAILS

MODEL ARD
¼"
WEIGHT 4¾ LBS. 7½" LONG

The UNITED STATES ELECTRICAL TOOL Co.
CINCINNATI, OHIO

Piper Cub Super Cruiser. Piper Aircraft Company, Lock Haven, Penna. 3-place, closed, land, high wing monoplane.

Some of the sizes and shapes of Summerill aircraft tubing in the Piper Aircraft Company stockroom.

THERE GOES A PIPER CUB—

and 700 feet of AIRCRAFT TUBING in 56 Different Sizes

Of course you can't see it, but it's there—in fuselage and landing gear, in the wing and tail assemblies of this Piper Cub are approximately 700 feet of aircraft steel tubing, in 56 different sizes and a variety of shapes.

Summerill has been supplying the aircraft industry with seamless steel aircraft tubing since World War I. The Piper Cubs of today (to say nothing of the thousands of pre-war Cubs and the Army version of World War II) are climbing in production records and public acceptance with the help of Summerill tubing.

If you do not have a copy of *"Aircraft Tubing Data"* write for one today. It is a "must" in the library of engineers, designers and other technical personnel.

Sales Offices:

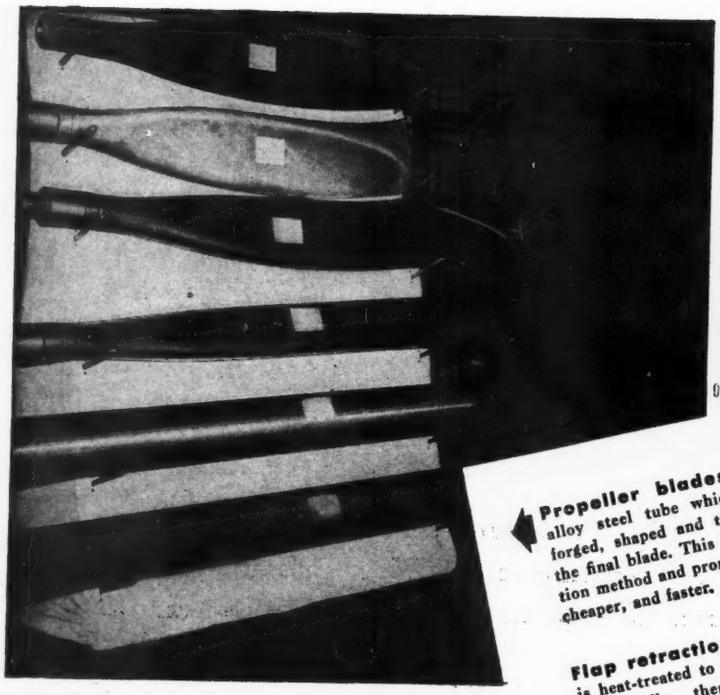
Buffalo
Chicago
Cincinnati
Cleveland
Dayton
Detroit
Hartford
Los Angeles
Milwaukee
Newark
Philadelphia
Pittsburgh
Rochester, N. Y.
Syracuse

SUMMERILL TUBING COMPANY

Affiliated with EDGAR T. WARD'S SONS CO. and COLUMBIA STEEL & SHAFTING CO.

BRIDGEPORT • MONTGOMERY COUNTY • PENNA.

Whatever type you build

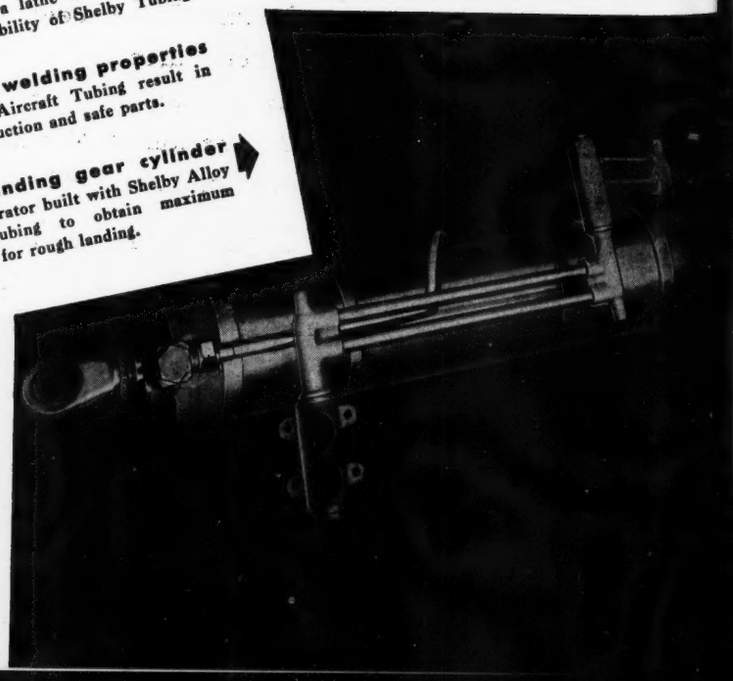


Propeller blades start with an alloy steel tube which is machined, forged, shaped and trimmed to make the final blade. This is a mass-production method and promises to be better, cheaper, and faster.

Flap retraction jack for the B-29 is heat-treated to a tensile strength of 125,000 lbs., then threaded with one pass through a lathe which indicates good machinability of Shelby Tubing.

Excellent welding properties of Shelby Aircraft Tubing result in faster production and safe parts.

Main landing gear cylinder of a Liberator built with Shelby Alloy Steel Tubing to obtain maximum strength for rough landing.



Shelby Aircraft Tubing

Will help make it better!

JET PLANES use alloy and stainless steel tubing to resist extremely high temperatures.

Flying freighters need the strength of alloy steel tubing to absorb tremendous landing jolts.

Helicopters and cubs need the combination of light weight and high strength for vital parts—and they get it with Seamless Steel Tubing.

Steel tubing is versatile. You can bend it, weld it, shape it into almost any form you want. It is easy to machine, withstands vibration fatigue and retains its strength under extremes of heat and cold.

No matter what kind of plane you plan to build, you'll find Shelby Seamless Aircraft Tubing will help to make it stronger, lighter, and lower in cost.

Our metallurgists will be glad to give you any assistance you need in designing tubular parts for new planes. Just write or call.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Tubing Specialties Division

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

SHELBY SEAMLESS *Aircraft Tubing*

NATIONAL TUBE COMPANY · USS STEEL · UNITED STATES STEEL

EVERY SUNDAY EVENING, United States Steel presents *The Theatre Guild on the Air.* American Broadcasting Company coast-to-coast network. Consult your newspaper for time and station.

UNITED STATES STEEL

NORTHROP AIRCRAFT, INC.

Announces a New Division

The NORTHROP AERONAUTICAL INSTITUTE

dedicated to the training and advancement of men for careers in aviation

The entire aviation industry recognizes the critical shortage of aeronautical engineers, airline maintenance specialists, and expert master mechanics. Like other employers of aviation personnel, Northrop has found far too many of the present applicants for positions lacking in *over-all* aircraft knowledge. To handle a responsible job for civilian air lines, air bases, maintenance depots, or manufacturers, today's employee must have up-to-the-minute, comprehensive training in the handling of *all types* of civilian aircraft.

To meet this need, NORTHROP AERONAUTICAL INSTITUTE has been founded.

In this completely new school in the midst of the Northrop plant, students will learn the aviation craftsmanship of *today*—and *tomorrow*. They will be located on the Northrop mile-long air field, surrounded by intensely interesting research and development work—jet propulsion, gas-turbine aircraft engines, radar, and advanced airplane designs.

Through the new courses offered by Northrop Aeronautical Institute, students can obtain specialized education for important positions in postwar aviation. Every detail of every course is fitted to the new aviation requirements. Yet the Northrop training programs are already proved by the education of thousands of employees and Air Forces personnel.

Each Northrop student gets the benefit of completely modern technical information and educational methods, as well as extensive equipment for practical shop experience. Even the specially designed school buildings are new.

We believe that the Northrop Aeronautical Institute will provide aviation training that is unparalleled in its value both to students and to the aviation industry. It is our sincerest wish that in 1946 and following years, the name "Northrop Graduate" will be a synonym for a *versatile* and *valued expert* in the field of aviation.

Inquiries invited for classes now forming.

Northrop Aeronautical Institute
(A division of Northrop Aircraft, Inc.)
1507 E. BROADWAY, HAWTHORNE
LOS ANGELES COUNTY, CALIFORNIA

NORTHROP AERONAUTICAL INSTITUTE
1507 E. BROADWAY
HAWTHORNE, CALIFORNIA

Please send me information on the training courses checked.

Name_____ **Age**____

Address_____

City_____ **Zone**____ **State**_____

Check one: Veteran☐ In Service☐ Civilian☐

A-1

- ☐ Aeronautical Engineer
- ☐ Airline Maintenance Specialist
- ☐ Airplane Mechanic
- ☐ Engine Mechanic
- ☐ Master Airplane and Engine Mechanic (A & E)
- ☐ Home study course – Airplane and Engine Maintenance

"With Gulf Lasupar Cutting Oil we increased production per tool grind and improved thread finish"

says this Factory Manager

Actual photo of Factory Manager (center) consulting with a Gulf Service Engineer on results with Gulf Lasupar Cutting Oil in milling breech threads on artillery tubes.

"GULF LASUPAR CUTTING OIL has helped us do a better thread milling job," says this Factory Manager. "A very smooth finish is required —and we get it with Lasupar. This cutting oil also made possible a big increase in production per tool grind—important on this job because the tool is very difficult to dress."

Gulf Lasupar Cutting Oil consistently produces better results on the machining jobs for which it is engineered! This top quality cutting oil may be the answer to your tough, hard-to-speed-up machining operations—and to your requirements for an exceptionally fine finish on the work. Call in a Gulf Service Engineer today and let him demonstrate how Gulf Lasupar Cutting Oil can help you improve your machining practice.

Gulf Lasupar Cutting Oil—and the other quality oils in Gulf's complete line—are available to you through 1200 warehouses located in 30 states from Maine to New Mexico. Write, wire, or phone your nearest Gulf Office.

GULF OIL CORPORATION · GULF REFINING COMPANY

GULF BUILDING · PITTSBURGH 30, PA.

GULF INDUSTRIAL LUBRICATION

GULF QUALITY CUTTING OILS

Gulf Lasupar Cutting Oils A, B, and C
Gulf Electro Cutting Oils A, B, and C
Gulf M-L Cutting Oils A, B, and C
Gulf Cut-Aid · Gulf Cutx B
Gulf L. S. Cutting Base A and B

Gulf Oil Corporation · Gulf Refining Company A
3800 Gulf Building, Pittsburgh 30, Pa.

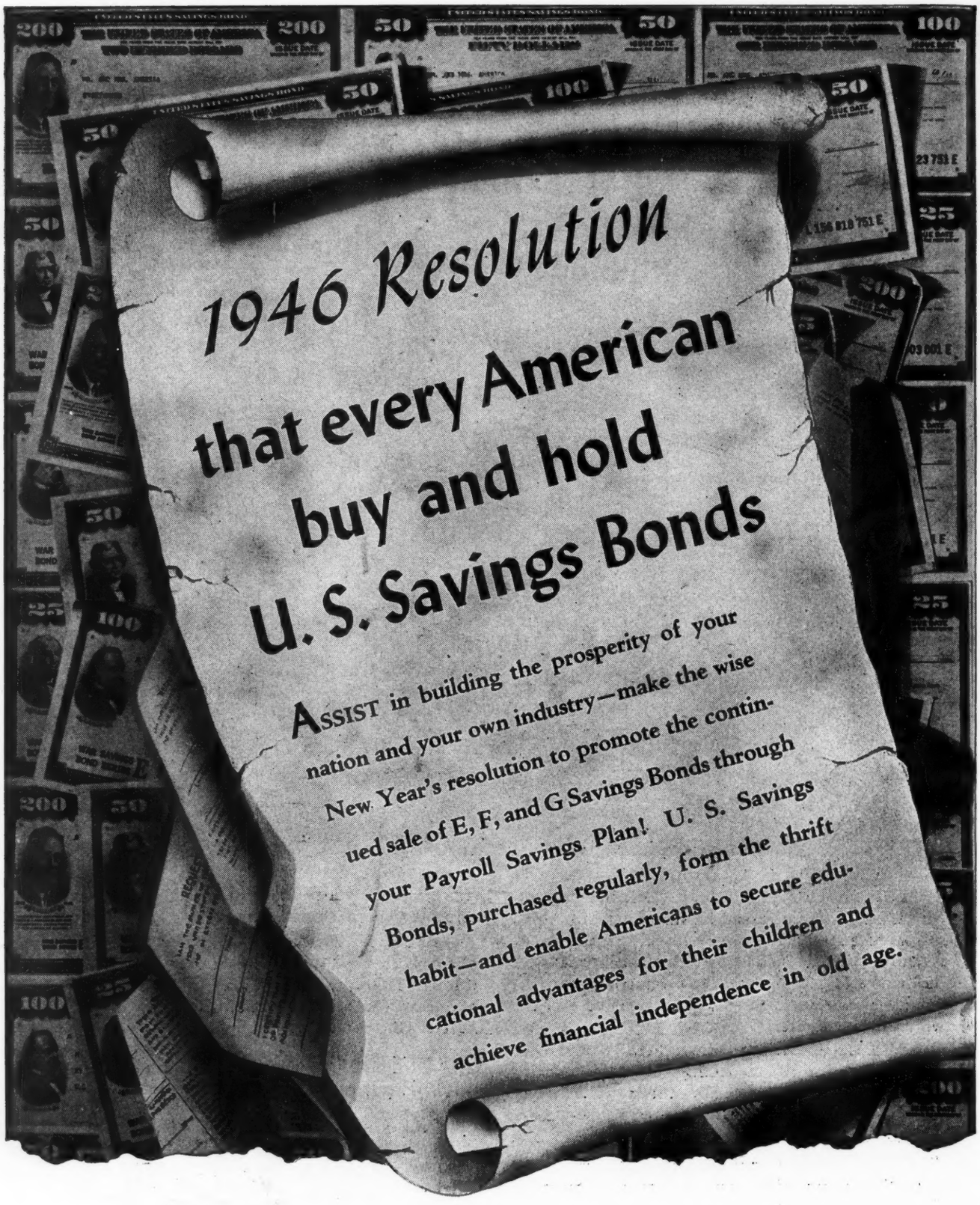
Please send me, without obligation, a copy of the booklet, "Gulf Cutting Oils," which includes a helpful Machining Guide.

Name.....

Company.....

Title.....

Address.....


1946 Resolution
that every American
buy and hold
U. S. Savings Bonds
ASSIST in building the prosperity of your nation and your own industry—make the wise New Year's resolution to promote the continued sale of E, F, and G Savings Bonds through your Payroll Savings Plan! U. S. Savings Bonds, purchased regularly, form the thrift habit—and enable Americans to secure educational advantages for their children and achieve financial independence in old age.

The Treasury Department acknowledges with appreciation the publication of this message by

AVIATION

This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and War Advertising Council

"PITTSBURGH" DEVELOPMENTS IN AIRPLANE GLAZING

For B-32 Ball Turrets . . . Cast Plastic Spherical Sections

Consolidated Vultee Corp. "Dominator" — Sperry Gyroscope Co. Photo

THE PROBLEM: Required, a ball turret with large transparent spherical sections, sufficiently clear, strong and stable to withstand the numerous extreme conditions encountered in high altitude combat flying.

THE SOLUTION: Cast spherical plastic panels made of Pittsburgh Plate Glass Company's clear transparent thermally set CR-39 resin.

These panels proved to be optically adequate for aiming guns; strong and rigid enough to withstand wind loads at the nose of the plane; able to withstand decomposition by intense ultra-violet rays at great altitudes; able to endure the heat of the tropical sun and anti-icing hot air without deforming. In fact, this "Pittsburgh" product measured up to *all* the requirements.

MANY years of peacetime experience enabled Pittsburgh Plate Glass Company to maintain leadership in producing special purpose glasses and plastics for fighting and bombing planes. The advanced techniques and improved facilities developed during the war years are your further assurance of highest quality transparent panels for commercial and civilian planes when you use products which bear the name "Pittsburgh".

If you have any problem which concerns airplane glass or glazing, we invite you to write us for detailed information.

Address Pittsburgh Plate Glass Company, 2054-6 Grant Building, Pittsburgh, Pennsylvania.

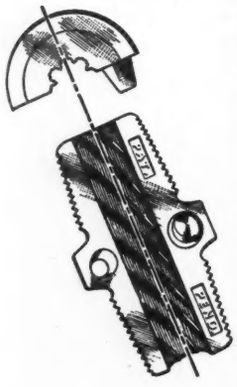
PPG "PITTSBURGH" *stands for Quality Glass and Paint*

PITTSBURGH PLATE GLASS COMPANY

SPECIALISTS IN AIRPLANE GLASS · MAKERS OF DUPLATE AND FLEXSEAL SAFETY GLASS AND OF MULTIPLATE BULLET-RESISTING GLASS

SAFE-LINE WIRE ROPE CLAMP *Never Slips*

FASTER - SAFER - ELIMINATES SPLICING



FORGED AND MASTER COINED TO FIT ROPE

SIZES 1/16" TO 3/4"

Safe-Line double spiral splines fit each wire and strand, providing a *never slip* grip, without cutting action to the rope. Replacement guarantee on clamp against breakage and fracture.

Millions in daily use prove *Safe-Line* the right way to hold wire rope securely. It's the better way, too!

Better because *Safe-Lines* are faster than splicing and serving, or using U-bolts.

Better because *Safe-Lines* outpull the strongest rope, hold a tight thimble, minimize rope or sling breakage.

Better because *Safe-Lines* are easy to use and re-adjust, without special tools or skilled labor.

Better too, because *Safe-Lines* enclose sharp wire ends, preventing personal injury and mental hazards.

Try this better way that saves you time and money.

APPROVED BY UNDERWRITERS' LABORATORIES AND CIVIL AERONAUTICS ADMINISTRATION

WRITE FOR DESCRIPTIVE PRICE-LIST FOLDER

NATIONAL PRODUCTION COMPANY
4573 ST. JEAN AVENUE • DETROIT 13, MICHIGAN

LINEAR O-Rings . . .

Simple, Economical, Effective

"The Versatile Packing"

Normally circular in cross-sections, Linear O-Rings are precision molded to close tolerances, from a highly resilient synthetic rubber compound; resistant to all widely used hydraulic fluids and many other industrial liquids and gases. O-Rings reduce manufacturing costs, require less space and seal effectively in both directions at low and high pressures. These elastic packing rings are readly replaceable, foolproof and require no adjustments. Frictional drag is low. Some recommended practices for O-Ring installation are shown in the accompanying diagrams.

On high pressure installations exceeding 1500 p. s. i., or where clearance ("C") is more than .004", the use of leather back-up rings is suggested to prevent extrusion. Back-up rings may be used on lower pressure applications, too, and will assist in lengthening packing life.

For all static seals, but especially those troublesome low pressure conditions (less than 100 p. s. i.), the application of semi-vee groove is recommended.

All pneumatic equipment should provide for lubrication of the packing. Diagram shows a suggested arrangement of felt washers saturated with oil, installed on each side of O-Ring groove.

Sample rings will be furnished on request. Consult Linear engineers for the application of Linear O-Rings to your new equipment designs.

Note: Covered by Christensen United States patent No. 2,180,795. All O-Rings sold by Linear are manufactured under royalty agreement with patentee.

LINEAR INCORPORATED
EXECUTIVE OFFICES & FACTORY
STATE ROAD & LEVICK STREET
PHILADELPHIA 35, PENNA.

SIMMONDS PRECISION-BUILT

PUSH-PULL CONTROLS

Solve problems in . . .

PRECISION — VIBRATION

Are you taking advantage of the most advanced design methods in handling your remote control problems?

Simmonds Push-Pull Controls, developed to meet exacting aircraft standards, are being increasingly specified by industrial engineers in many fields. More than half a million Simmonds controls are today giving rugged, trouble-free service in installations that require the ultimate in accuracy—eliminating awkward pulley-and-cable and rod-and-bellcrank set-ups. Especially successful in solving problems involving vibration and difficult contours. A wide variety of accessories and fittings make Simmonds controls adaptable to many purposes.

Let Simmonds engineers help solve your remote control problems. There is no obligation.

Send Your Control Problems to Simmonds Control Headquarters

Simmonds

AEROCESSORIES, INC.

30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

Branch Offices: Dayton, Ohio • Glendale, California • Montreal, Canada

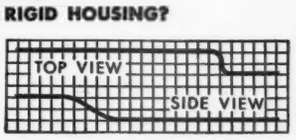
Simmonds PRODUCTS INC.

Let Simmonds Analyze Your Control Problem

Simply submit the basic requirements, as follows:

- **What does the control operate?**
- **LOAD: Compression (lbs.) Tension (lbs.)**
- **VIBRATION CHARACTERISTICS**
- **TEMPERATURE CONDITIONS**
- **PRESENT SYSTEM**
- **FLEXIBLE OR RIGID HOUSING?**

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.



OTHER SIMMONDS PRODUCTS:

Pacitor (Electronic) Fuel Gauges — Spark Plugs
Hydraulic Accumulators — Automatic Engine Controls
Aneroid Capsules — Chronometric Radiosondes
Fasteners and Clips of Specialized Design

your wire in our hands...

Callite fine alloy wires

FOR SPRINGS, CONTROL CABLES, INSTRUMENT PARTS, MESH AND SIEVES

YOU CAN RELY on the uniform elongation and tensile properties of Callite fine wire to speed up production, to lower operating costs. Accurate to size, perfect roundness, close engineering control through every process from ore to spooling, combine to produce uniformity and exact adherence to your specifications from one order to another.

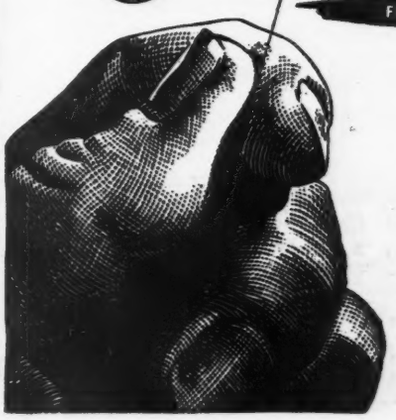
Our wartime experience in developing special wires, plus our quarter-century of metallurgical specialization is available to you for product development.

CONSULT OUR ENGINEERS for help on material selection or applications. Prompt deliveries on standard wire types for every purpose. Callite Tungsten Corporation, 545 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

CALLITE TUNGSTEN CORPORATION CT

Callite

FINE WIRES



Precision diameters down to .002" or smaller in aluminum, phosphor bronze, stainless steel, silver, nickel silver, silicon bronze, commercial bronze, brasses, monel, "clad" wires and special alloys.

WHEN BEARINGS ARE *Vital*-

OLDS BEARING BRONZE MEETS EVERY TEST!

PHYSICAL SPECIFICATIONS

Tensile Strength— 22,000 psi

Tensile Yield Strength at .35% set— 16,000 psi

Compression Yield Strength at .35% set— 17,000 psi

Elongation in 2" 3%

From "spudding in" till "she's on the pump" the bearings in oil well drilling equipment take heavy loads and high strains and *must not fail.* OLDS BEARING BRONZE is alloyed and fabricated to resist the shock and strain of vibration and high speeds. The inherent toughness of the alloy with its lead content increases wearing qualities and reduces bearing friction. For every bearing problem, count on OLDS BEARING BRONZE for longer bearing life.

Write for Bulletin —giving specifications and stock sizes.

OLDS ALLOYS Company

Complete Facilities... *TO SERVE YOU!*

★ DROP FORGING
★ ALUMINUM CASTING
★ WELDING

Throughout the war, we served 100% as sub-contractors for aircraft and other manufacturers. NOW—our equipment and skills will serve manufacturers demanding higher quality at lower cost in parts and assemblies. Write, or wire, today for full information regarding our ability to serve you, too!

INDUSTRIAL TYPE WHEELS A SPECIALTY!

★ AIRCRAFT MECHANICS Inc.
COLORADO SPRINGS, COLORADO

DESIGNERS • • • ENGINEERS • • • MANUFACTURERS

FITZGERALD GASKETS

FOR AIRCRAFT ENGINES

GASKET CRAFTSMEN FOR 40 YEARS

Write for information

FITZGERALD MANUFACTURING COMPANY
TORRINGTON, CONN.

BRANCHES CHICAGO AND LOS ANGELES
CANADIAN FITZGERALD, LTD., TORONTO

FITZGERALD GASKETS
THE COMPLETE LINE THAT COMPLETELY SATISFIES

IT'S C. A. A. APPROVED!

THE "SPAR-TAN CHROME PROCESS" PATENT APPLIED FOR GIVES

Those gremlins, Wear, Drag and Pumper, really get the old brush-off when the "Spar-Tan Chrome Process" comes on the job.

Dynamometer tests have registered substantial increases in h.p., while maintenance records tell of 5 to 7 times normal cylinder life and 3 to 5 times average ring life—a sure way of reducing lay-up time and other maintenance costs.

The "Spar-Tan Chrome Process" is an exclusive method of electroplating such vital, shock-absorbing parts as Aircraft Cylinders, Diesel Liners, Crankshafts and Camshafts —the surface of the plated part containing hundreds of microscopic indentations to retain the oil.

A limited number of openings for jobbers are still available. Write for latest bulletin, SCP-100.

LONGER LIFE

MORE POWER

MORE SAVINGS

SPAR-TAN ENGINEERING CO.
1504 E. Washington Blvd. Los Angeles 21, Calif.

IRVIN Air Chute

"SINGLE-RELEASE" Harness

UNITED NATIONS' FLYERS *are using it for* SAFER LANDINGS

A one-hand turn and a tap on the single frontal disk instantly releases the harness . . . leaving the flyer entirely free. Accidental release is impossible before disk is "set" for action.

All United Nations' Air Forces for years have used IRVIN as standard equipment . . . and now the Irvin "Single-Release" harness is acknowledged as superior for all landings. IRVIN, as always, leads in Safety.

Twist & Set *Tap for Release* *Harness Falls Off*

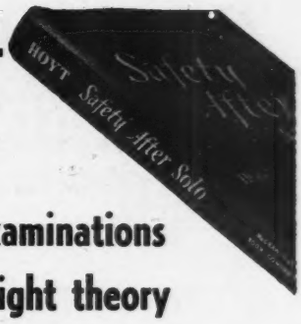
IRVING AIR CHUTE CO., Inc.

Main Office: 1670 Jefferson Ave., Buffalo, 8, N. Y.

Complete Factories in Buffalo, N. Y., Glendale, Calif., (1500 Flower St.), and Lexington, Ky., U. S. A.—Canada, England and Sweden . . . All Serving the United Nations' Air Forces.

BUY MORE BONDS

3 McGRAW-HILL BOOKS



to help you master flight safety—CAA examinations design and flight theory

SAFETY AFTER SOLO

By JOHN R. HOYT
Lt. Comdr., USNR (Naval Aviator)

Here are practical rules for any pilot who wants to become a "million miler." This approach to the problem of safety in flight analyzes the danger periods which all pilots go through, explains why and when they come, and shows you *that they can be avoided.* It tells you how to acquire the right mental attitude, correct technique, and the knowledge of what to expect—the three things that make up the formula for safe flying. This is a "must" book for all pilots—a book that will help you learn by the mistakes of others—not by your own. **336 pages, 51 illustrations, $3.00**

Questions and Answers for AIRPLANE AND ENGINE MECHANICS

Compiled and Edited by AVIATION RESEARCH ASSOCIATES in Cooperation with the Technical Staffs of the ACADEMY OF AERONAUTICS, THE CASEY JONES SCHOOL OF AERONAUTICS

Brush up on airplane maintenance and repair practice with these more than 3,000 sound questions, and answers, based on the requirements of the Civil Aeronautics Administration examinations for certification as airplane and engine mechanics. Here are the methods and facts you need to know to do a good job on airplanes, from metal working and welding, fabric and doping, rigging and alignment, hydraulics and systems, right through propellers and civil air regulations. Here is good, sound information on handling aircraft engines, covering lubrication and systems, carburetion and fuel systems, induction and induction systems, propellers, engine overhaul and maintenance, as well as civil air regulations. **502 pages, 11 illustrations, $4.00**

THEORY OF FLIGHT

By RICHARD VON MISES
Graduate School of Engineering, Harvard University

McGRAW-HILL PUBLICATIONS IN AERONAUTICAL SCIENCE

This up-to-the-minute reference source of modern aircraft design and operation presents a thorough analysis and description of flight theory, with extensive experimental data, charts and formulas, etc. It contains a full treatment of fundamental principles of aerodynamics, and gives a detailed account of the theory of airplane wings and propellers. Presents the graphical and analytical methods of performance computation, and discusses the dynamics of non-uniform motion with reference to airplane control and stability. Reliable experimental data are quoted extensively and theoretical results are carefully compared with the empirical evidence. **629 pages, 408 illustrations, $6.00**

10 DAYS ON APPROVAL—SEND THIS COUPON

McGRAW-HILL ON-APPROVAL COUPON

McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y.

Send me the books checked below for 10 days examination on approval. In 10 days I will pay for books plus few cents postage or return books postpaid. (We pay postage on cash orders; same return privilege.)

- ☐ **Hoyt—Safety After Solo, $3.00**
- ☐ **Aviation Research Associates—Questions and Answers for Airplane and Engine Mechanics, $4.00**
- ☐ **Von Mises—Theory of Flight, $6.00**

Name .....

Address .....

City and State .....

Company .....

Position ..... AV 1-46

In Canada: Mail to Embassy Book Co., 12 Richmond St. E., Toronto, 1

DELICATE
MACHINING
OF EXPERIMENTAL PARTS!

Our experience of 22 years in the machining of automotive and aircraft engine parts assures you of the highest type of work whenever you have experimental parts that require delicate machining.

Write us concerning Your Requirements

GOVRO-NELSON CO.

1931 Antoinette, Detroit 8, Mich.

PRECISION *Machining*

NOW

A New WITTEK Hose Clamp

For Personal Planes

TYPE FBP

TYPE FBSS

TYPE WWD

The great fund of aviation production knowledge developed during the war by aircraft parts manufacturers is now being turned to peacetime planes, commercial and personal. Wittek now offers manufacturers of these planes the FBP Hose Clamp.

The new Wittek FBP Hose Clamp, made from stainless steel and having a band ½" wide, follows the basic FB design, incorporating lighter construction and economy—yet retaining the high Wittek standards for dependability, high grade materials and good workmanship.

In addition to the FBP, FBSS and WWD, Wittek manufactures a complete line of Hose Clamps of various designs. There is a Wittek Hose Clamp to meet every aircraft application. Write for full particulars.

WITTEK
MANUFACTURING CO.
4305-15 W. 24th Place, Chicago 23, Ill.

Aviation HOSE CLAMPS

What

Makes A Mailing *CLICK*?

Advertising men agree—the list is more than half the story.

McGraw-Hill Mailing Lists, used by leading manufacturers and industrial service organizations, direct your advertising and sales promotional efforts to key purchasing power. They offer thorough horizontal and vertical coverage of major markets, including new personnel and plants. Selections may be made to fit your own special requirements.

New names are added to every McGraw-Hill list daily. List revisions are made on a twenty-four hour basis. And all names are guaranteed accurate within two per cent.

In view of present day difficulties in maintaining your own mailing lists, this efficient personalized service is particularly important in securing the comprehensive market coverage you need and want. Ask for more detailed information today. You'll probably be surprised at the low over-all cost and the tested effectiveness of these hand- picked selections.

Direct Mail Division

McGraw-Hill Publishing Co., Inc.

330 West 42nd Street *New York, 18, N. Y.*

WHERE TO BUY

Accessories, Materials & Supplies for the Aviation Industries

TAKE THE LOAD OFF YOUR MACHINISTS

by supplying them with these new adjustable tool chest dollies. Adjusts in a jiffy to fit various size chests. Made of hardwood, with steel wheel ball bearing swivel casters. With a few in your tool crib your machinist will not waste time getting the help of another fellow, or wait until a company truck is free, to move his chest. Will carry up to 75 lbs., yet dolly weighs but 2 lbs. 4 oz. Shipped postpaid anywhere in the U. S. for $5.00 per or $50.00 per dozen.

TOOL CHEST DOLLY MFG. CO.
806 E. 4th Pl., Los Angeles (13) Calif.

THE FEDERAL ALL-METAL SKI

APPROVED LIGHT WEIGHT SKIS AND RIGGERS FOR ALL SIZES, TYPES AND MODELS OF AIRCRAFT

FEDERAL AIRCRAFT WORKS, MPLS. MINN.

If this or other advertising does not supply the information concerning products or services wanted, please write:

AVIATION,
New York City.

Hindview
MIRRORS

WHITEHEAD STAMPING COMPANY *Est. 1903*
1665 W. Lafayette Blvd. • Detroit 16, Michigan

ENGINEERS
Work in California!

NORTH AMERICAN AVIATION

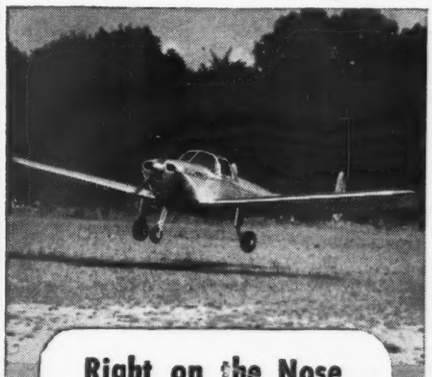
Is designing aircraft of the future and needs experienced:

ENGINEERING DESIGNERS
& DRAFTSMEN
AERODYNAMICISTS
STRESS ANALYSTS

Biggest research and development projects in company's history offer good pay, fascinating work and opportunity for the future.

Write E. R. Carter, Engineering Dept., 5601 Imperial Highway, Inglewood, Cal.

North American Aviation, Inc.
SETS THE PACE



Right on the Nose of the NEW Ercoupe

Again Ercoupe chooses Sensenich as standard equipment ... because Sensenich—world's largest manufacturer of wood aircraft propellers—knows how to design and build for maximum efficiency. Swing a Sensenich and be sure!

Prompt repair service now available.

Standard of Performance

AIRCRAFT SENSENICH PROPELLERS

SENSENICH BROTHERS
LANCASTER, PA. GLENDALE, CALIF.

Send for

It's new—amazingly effective and surprisingly inexpensive. Vibrashock* triple-action unit mounts really absorb vibration and cushion shock. Compare Vibrashock with any other unit type mount—and see the marked improvement in performance. We believe Vibrashock will solve your vibration problems.

*trade mark

ROBINSON AVIATION, INC.
Teterboro Air Terminal, Dept. A. 1.
Teterboro, New Jersey
3757 WILSHIRE BLVD., LOS ANGELES 5, CALIFORNIA

AVIATION'S MARKET PLACE

CLASSIFIED ADVERTISING

Used planes engines and parts for sale. Trade or wanted special services of distributors. Fixed base operators etc.

(Sales and Service—Storage—Repairing—Charter—Aerial Towing or Exhibitions—Special Instruction)

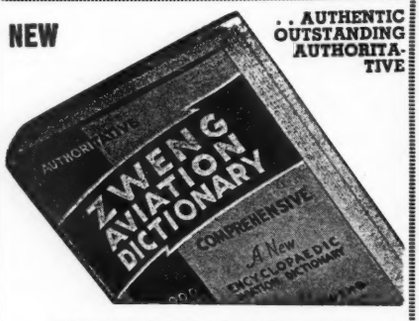
Employment — Selling — Business Opportunities: Offered or Wanted.

Rates: Undisplayed. 10 cents a word, minimum $2.00 (Position wanted. ½ the undisplayed rate: box number counts as 10 words.) Displayed $7.25 per inch. Contract rates on request.

Address Aviation "Classified". 330 W. 42nd St., New York 18, N. Y. Phone MEdallion 3-0700—Ext 556

NEW ADVERTISEMENTS received by January 24th will appear in the February issue within space limitations

NEW . . AUTHENTIC OUTSTANDING AUTHORITATIVE



AVIATION DICTIONARY

by CHARLES A. ZWENG

Member, Institute of Aeronautical Sciences
Author of Radio & Instrument Flying, etc.

A new Encyclopaedic AVIATION DICTIONARY bristling with thousands of pertinent aviation words, and terms defined and explained: the keenest working tool in your aviation library . . . a necessary authority for the airman, instructor, executive and aviation student. Price only $6.00 postpaid or C.O.D.

METEOROLOGY for AIRMEN (Zweng) A new "first" book fully illustrated. Prepares for advanced pilot and ground instructor ratings. New "multiple choice examinations" included. $3.00.

Aircraft & Engine Mechanic: Two books in one. Especially written and illustrated for preparation covering the government test. "Typical Multiple Choice" examinations on Hydraulics, Welding, Sheet Metal, Lubrication, Ignition, Engines, Aircraft, Rigging, Propellers, etc. Only $3.00 postpaid or C.O.D.

AERONAUTICAL TRAINING (by Zweng) Prepares for Private & Commercial Rating (New Multiple Choice Examinations included). $3.00.

Veterans: Our Training Div. gives flight instruction under G-I Bill of Rights. Write for information.

Free Catalog—Dealer territory open

PAN AMERICAN NAVIGATION SERVICE
Dept. M
12021 Venture Blvd. N. Hollywood, Cal.

Don't forget the

Box Number

. . . when answering the classified advertisements in this magazine. It is our only means of identifying the advertisement you are answering.

Prepare Now For Your
INSTRUMENT RATING
At Our Conveniently Located
LINK TRAINER SCHOOL
Eastern Air Navigation Service
5 W. 46 St., NYC — Long. 3-6515
Celestial & Radio Nav. Day—Eve.

POSITIONS WANTED

AIRCRAFT ENGINEER: Broad experience as technical executive in design, development, test, organization, liaison, service, sales. Now in USAAF as an executive engineer, ATSC, Engineering Division Headquarters—expect to be released soon. Would like to contact concerns now engaged in or contemplating aviation work, preferrably west coast. PW-960, Aviation, 520 N. Michigan Ave., Chicago 11, Ill.

AIRCRAFT DEVELOPMENT: Young man wishes position. Been in charge of experimental work on light and fighter planes for past six years. This included fool-proof flight. PW-961, Aviation, 520 N. Michigan Ave., Chicago 11, Ill.

EXPERIENCED PROCUREMENT Executive available. Eighteen years of aircraft background. Fully qualified to supervise material control, purchasing, expediting and sub-contracting departments. Can furnish excellent references. Prefer connection with established aeronautical concern. Now employed. PW-962, Aviation, 520 N. Michigan Ave., Chicago 11, Ill.

DISCHARGED U. S. Navy veteran wishes job with private individual or small company. 12 years with the world's largest airline and 3½ years U. S. Naval Air Transport Command as flight engineer and engineering crew. Have legally logged 4,000 hours flying time in aircraft from C-3 Aeronicas to 4 engine seaplanes. 34 years old. Not married and free to travel. PW-963, Aviation, 330 W. 42nd St., New York 18, N. Y.

REBUILDING

AIRCRAFT BATTERIES rebuilt. New Plates and separators. Your case cover and costs. Let us quote. Bowers Battery Mfg. Co., Inc., Reading, Pa.

FOR SALE

NEW TIRES: 8.00x4, 6.00x6, 7.00x4, 4-ply $11.75. Tubes $3.25. We wholesale and carry large stocks. Propellers, Spark Plugs, Batteries, Tailwheel Assemblies, Windshield Pryaline. Dope, Fabric. Bob Trader Aero Supply, 929 Penn Ave., Pittsburgh, Pa.

OPPORTUNITY OFFERED

WANTED A Pilot with some air line pilot experience to represent a well-established employee-representing organization. This is not a flying position. Executive work only with some travel. Employer-employee relations handling ability necessary. Veteran preferred. RW-941, Aviation, 520 N. Michigan Ave., Chicago 11, Ill.

WANTED: SALES Engineers. Specialized aeronautical equipment. High pressure men need not apply. We present our cases on the basis of merits only. Must be able to fly. Give full details first letter. Hugh C. Robbins and Associates, P. O. Box 346, Troy, Ohio.

BOOKS WANTED

JOURNAL OF Aeronautical, Science odd volumes and copies. Also other scientific journals. B. Login & Son, Inc., 29 East 21st St., New York 10, N. Y.

INVENTIONS WANTED

INVENTORS: We seek for our clients specialized, practical, mechanical equipment, preferably patented and tried in the aircraft field to manufacture and distribution. Royalty basis or any other mutual arrangement.

HUGH C. ROBBINS AND ASSOCIATES
Business Engineers and Aeronautical Consultants
P. O. BOX 346 TROY, OHIO

WANTED AT ONCE

DESIGN ENGINEERS DRAFTSMEN

Opportunities now exist for qualified Design Engineers and Draftsmen for work on the new Stratocruiser, C-97 Military Transport, and other new developments.

Here's an opportunity to become associated with one of the world's leaders in aircraft design and production, and to participate in the design of the aircraft of tomorrow.

- *Good Salaries*
- *Pleasant Working Conditions*

BOEING AIRCRAFT COMPANY
Seattle 14, Washington

Nationally known manufacturer of aircraft radio is seeking top-flight representatives to contact aircraft manufacturers and distributors. Previous radio experience necessary. Aircraft experience desirable, but not essential. Generous salary and permanent connection for right men. When writing, the more background information you supply the better your chances for a prompt interview.

RA-959, Aviation
330 West 42nd St., New York 18, N. Y.

AERONAUTICAL ENGINEER WANTED

Knowledge or experience in aircraft propeller design desired but not necessary. To supervise engineering department of prominent wood propeller manufacturer. State age, marital status, details of education, experience and salary expected. Address letters to

SENSENICH BROTHERS
LANCASTER PENNA.

DESIGNERS AND DRAFTSMEN
with experience on
Electric Actuators
Chicago Pneumatic Tool Co.
1241 E. 49th St., Cleveland, Ohio

AVIATION'S MARKET PLACE

AIRCRAFT ACCESSORIES AND INSTRUMENTS

SALES
REPAIRS

APPROVED REPAIR STATION 188

CARBURETORS • MAGNETOS • GENERATORS
ELECTRICAL EQUIPMENT • BATTERIES • SPARK PLUGS
VACUUM PUMPS • HYDRAULIC PUMPS • INSTRUMENTS

STANDARD AIRCRAFT EQUIPMENT CO.

ROOSEVELT FIELD • MINEOLA, L. I., N. Y. • GARDEN CITY 8753

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you menttion this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publisher to secure more advertisers and—more advertisers mean more information or more products or better service—more value—to YOU.

AERO TRADES
COMPANY
Roosevelt Field, L. I.

EXPERIMENTAL WORK
MODIFICATIONS

Specialists in Wood & Metal — Manufacturers of Airplane Parts

Government Approved Station 115

MILITARY RELEASE INSTRUMENTS

Sperry Directional Gyros	$85.00
Sperry Artificial Horizons (Caged adjustable Plane)	$85.00
Rate of Climb (self Contained)	$40.00
Turn and Bank, Bendix	$40.00
Sensitive Altimeters (Kollsman and Pioneers)	$37.50
Air Speeds-Kollsman	$15.00
Compass-Kollsman B-16	$17.50
Manafold Pressure Gages	$15.00
Vacuum Selector Valve	$5.00
Parker Vac. Reducer Valve	$2.00
Sperry Lge. Venturi	$12.00

ALL INSTRUMENTS ARE 100% OVERHAULED AND GUARANTEED TO SATISFY. 20% disc. in lots of three, except items under $20.00.

ALLIED AIRCRAFT CO.
CLARENDON HILLS, ILLINOIS

PROFESSIONAL SERVICES

LAWRENCE J. MARHOEFER
Consulting Engineer
431 MARKET STREET • CAMDEN, N. J.

LANCASTER, ALLWINE & ROMMEL
Registered Patent Attorneys
Booklet—"General Information Concerning Inventions & Patents" and "Fee Schedule" sent without obligation.
Patents—Copyrights—Trade-Marks
Suite 452, 815—15th St., N.W., Washington 5, D.C.

ANODIZING OF ALUMINUM
HARD CHROMIUM
PLATING
Philadelphia Rust-Proof Co.
3217 Frankford Ave. Phila., Pa.

National
CLASSIFIED ADVERTISING

for bringing business needs or opportunities to the attention of men associated in administrative, executive, management, sales and responsible technical, engineering and operating capacities with the industries served by

The SEARCHLIGHT SECTIONS of

Air Transport
American Machinist
Aviation
Aviation News
Bus Transportation
Business Week
Chemical and Metallurgical-Engineering
Coal Age
Construction Methods
Electrical Contracting
Electrical Merchandising
Electrical World
Electronics
Engineering News-Record
Engineering and Mining Journal
E & M J Markets
Factory Management and Maintenance
Food Industries
Power
Product Engineering
Textile World

For advertising rates or other information address:
Departmental Staff

McGRAW-HILL PUBLISHING CO., INC.
330 W. 42nd St., New York 18, N. Y.

ADVERTISERS IN THIS ISSUE

Adel Precision Products Corp. 202
Agaloy Tubing Co. 15
Aircraft Mechanics, Inc. 232
Airtronics Development Corp. 199
Albertson & Co., Inc. 13
Allen Mfg. Co., The. 168
Allied Products Corporation. 174-187
Aluminum Co. of America. 126
American Broach & Machine Co. 140
American Felt Co. 208
American Magnesium Corp. 31
Anemostat Corp. of America. . . . . Insert 122
Apex Machine & Tool Co., The. 210
Arrow Head Rubber Co. 29
Aviation Market Place. 236-237

Baldor Electric Co. 192
Bell Aircraft Corp. 118
Bendix Aviation Corp. . . . . Back Cover
Bendix Stromberg Carburetor. . . . . Back Cover
Berry Brothers 128
Booth Felt Co., The. 185
Bower Roller Bearing Co. . . . . Insert 103
Briggs & Stratton Corp. 158

Callite Tungsten Corp. 231
Cardox Corp. 186
Carpenter Steel Co., The. 112-113-145
Champion Spark Plug Co. 25
Chance Vought Aircraft. . . . . Front Cover
Chandler-Evans Corp. 198
Chicago Pneumatic Tool Co. 240
Cities Service Oil Co. 219
Cleveland Pneumatic Tool Co., The. 197
Collins Radio Company. 14
Columbia Steel Co. 224-225
Cone Automatic Machine Co., Inc. 191
Continental Diamond Fibre Co. 217
Cramer Posture Chair Co. 167
Curtiss-Wright Corp.—Engine Division. . . . 163
Curtiss-Wright Corp.—Propeller Division Insert 121

Darnell Corp., Ltd. 172
DeVilbiss Company, The. 152
Douglas Aircraft Co., Inc. 33
Dow Chemical Co. . . . . Third Cover
Dzus Fastener Co., Inc. 183

Eastern Stainless Steel Corp. 10
Eastman Kodak Co. 157
Elastic Stop Nut Corp. 209
Electric Auto-Lite Co., The. 17
Electric Storage Battery Co. 204
Elliot Co., B. K. 189
Ex-Cell-O Corp. 132

Fafnir Bearing Co., The. . . . . Insert 36
Fairchild Engine & Airplane Corp. 114
Federal Aircraft Works. 235
Federal Telephone & Radio Corp. 169
Fenwal, Inc. 181
Fitzgerald Mfg. Co. 232
Fulton Sylphon Co., The. 22

General Detroit Corp., The. 170
Goodrich Co., The B. F. 177
Govro-Nelson Co. 234
Grob Brothers 235
Gulf Oil Corp. 227

Hallicrafters Co., The. 200
Hansen Mfg. Co. 205
Hartzell Propeller Co. 184
Heim Company, The. 218
Holley Carburetor Co. 26
Huck Mfg. Co. 160

International Nickel Co., Inc., The. . . . 178-188
Irving Air Chute Co., Inc. 233

Johns-Manville 4

Kestor Solder Company. 208
Keuffel & Esser Company. 8
Kidde & Co., Inc., Walter. 203
Kinnear Mfg. Co., The. 185
Kollsman Instrument Co. 6

Laminated Shim Co., Inc. 175
Lawson Machine & Tool Co. 27
Leece-Neville Co., The. 206
Lempco Co. 165
Liberty Mirror Division Libbey-Owens-Ford Glass Co. 190
Linear, Inc. 230
Lisle Corp. 239
Lockheed Aircraft Corp. 173
Lord Mfg. Co. 215

McGraw-Hill Book Co. 233-239
McGraw-Hill Pub. Co., Inc. . . . . Insert 37-38
Mahon Co., The R. C. 11
Marlin Rockwell Corp. 220
McIntyre Co., The. 28
Mercury Aircraft, Inc. 192

National Production Co. 230
National Screw & Mfg. Co., The. 134
National Tube Co. 224-225
New York Air Brake Corp., The. 34
Norgren Company, C. A. 176
Norma Hoffman Bearings Corp. 150
North American Aviation, Inc. 235
North Bros. Mfg. Co. 190
Northrop Aeronautical Institute. 226
Northrop Aircraft, Inc. . . . . Insert 35

Ohio Seamless Tube Company. 211
Olds Alloys Company. 232
Onan & Sons, D. W. 184

Perfex Gage & Tool Co. 156
Permoflux Corporation 179
Phillips Petroleum Co. 32
Pioneer Parachute Co., Inc. 144

Piper Aircraft Corp. 146
Pittsburgh Plate Glass Co. 229
Plomb Tool Co. 7
Pressed Steel Co. 180
Pyrene Mfg. Co. 182

Radio Corp. of America. 171
Reeves Brothers, Inc. 212
Republic Aviation Corp. 166
Revere Copper & Brass, Inc. 143
Reynolds Metals Company. 213
Robinson Aviation, Inc. 235
Ryerson & Son, Inc., Joseph T. 161

Sellstrom Mfg. Co. 196
Sensenich Brothers 235
Silent Hoist Winch & Crane Co. 196
Simmonds Aerocessories, Inc. 231
Simonds Abrasive Co. 201
Sinclair Refining Co. . . . . Insert 104
SKF Industries, Inc. 194
Snap On Tools Corp. 30
Socony Vacuum Oil Co., Inc. 9
Solar Aircraft Co. 116
South Bend Lathe Works. 187
Southern Aircraft Corp. 16
Spar-Tan Engineering Co. 232
Sperry Gyroscope Co. 18
Standard Pressed Steel Co. 214
Starrett Co., The L. S. 189
Steel Founder's Society. 221
Sommerill Tubing Co. 223
Superior Tube Company. 155
Surface Combustion Corp. 12
Swan Engineering Co., Inc. 192

Teleoptic Co., The. 148
Texas Company. . . . . Second Cover
Time, Inc. 162
Timken Roller Bearing Co., The. 42
Tinius Olsen Testing Machine Co. 136
Tool Chest Dolly Mfg Co. 235
Torrington Company, The. 216

United Aircraft Products, Inc. 193
United States Electrical Tool Co. 222
U. S. Savings Bonds. 228
U. S. Steel Corp. 224-225
U. S. Steel Export Co. 224-225

Vickers, Inc. 124
Vinco Corp. 19-20-21

Waldes Koh-i-noor, Inc. 164
Walker-Turner, Inc. 23
Walter Motor Truck Co. 130
Wayne Pump Co., The. 154
Where To Buy. 235
Whitaker Cable Corp. 24
Whitehead Stamping Co. 235
Wittek Mfg. Co. 234
Wolfshead Oil Refining Co. 207
Wright Aeronautical Corp. 163-196
Wyman-Gordon 159

★ ★ ★

AVIATION'S MARKET PLACE

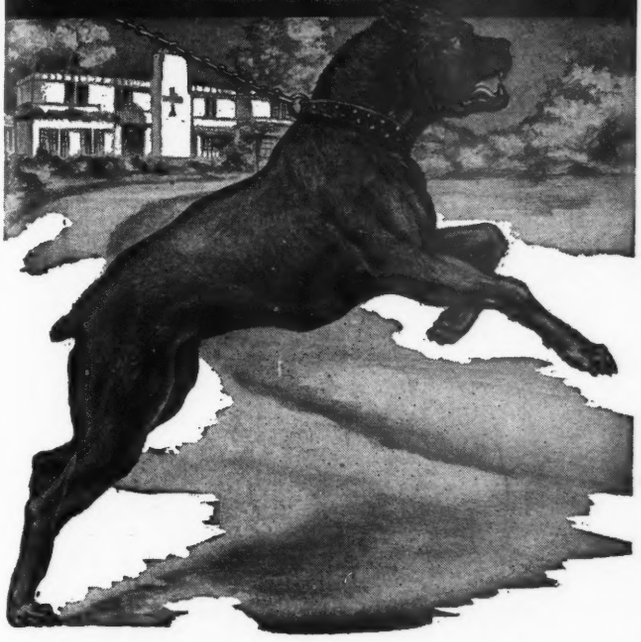
CLASSIFIED DISPLAY ADVERTISERS

BOOKS 236
EMPLOYMENT (Positions Wanted and Vacant). 236
FOR SALE 236-237
PROFESSIONAL SERVICES 237

CLASSIFIED DISPLAY ADVERTISERS

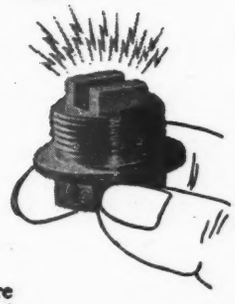
Aero Trades Co. 237
Allied Aircraft Co. 237
Boeing Aircraft Co. 236
Chicago Pneumatic Tool Co. 236
Eastern Air Navigation Service 236
Lancaster, Allwine & Rommell 237
Marhoefer, Lawrence J. 237
Pan American Navigation Service 236
Philadelphia Rust Proof Co. 237
Robbins & Assoc., Hugh C. 236
Sensenich Brothers 236
Standard Aircraft Equipment Co. 237

DANGER!
WARNS THE WATCHDOG



—And LISLE PLUGS warn in advance of DANGER! to aircraft engines

The presence of metal particles in the oil of an aircraft engine is often the first indication of dangerous hidden wear. Lisle Magnetic Plugs (which replace ordinary drain and fill plugs) give warning of this danger, in time to check it. A powerful magnet anchored in the Lisle Plug contacts the lubricant, traps metal particles, holds them for removal at inspection time. An important safety feature for all postwar aircraft engines!



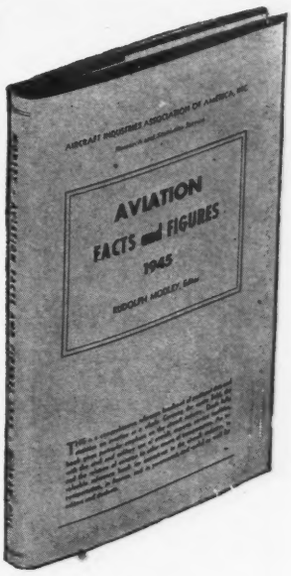
Designers, Engineers: Complete data and sample plug for testing will be sent free upon request. Write today!

LISLE CORPORATION
Box 1020, Clarinda, Iowa

Lisle Magnetic PLUGS

Get the facts on AVIATION and the AIRCRAFT INDUSTRY

with this extensive handbook of aviation data and statistics
—for executives in the aircraft industry, in transportation, in finance and in government—for editors, writers, and students of aviation



This book brings to all those concerned with accurate factural background for analyzing and forecasting aviation trends an invaluable collection of data on every aspect of the field. Sixteen sections give you pertinent facts and figures—introduced by a brief explanatory text serving to integrate the material—on civil and military use of aircraft, exports, service facilities, and the relation of aviation to other means of transportation, etc.

Will the industry be able to service the readjustment period? How large will be peacetime military orders? What will be the roles of commercial aviation, personal flying and airport development? Here is an authoritative source of carefully marshalled facts you need in answering these and other vital questions facing aviation.

Just Published

Aircraft Industries Association of America, Inc.

AVIATION Facts and Figures 1945

RUDOLPH MODLEY, *Editor*
173 pages, 6 x 9, 146 tables, $2.50

MANY important aspects—reconversion, financial resources, surplus disposal, government policies, the role of commercial aviation, personal flying, airport development, exports—must be studied and analyzed in evaluating the future of aviation in this country and abroad. Here are accumulated statistics on every possible phase of aviation, brought together from dozens of different sources to add a substantial contribution to the basic information on the increasingly significant role of air power.

Varied and useful data on . . .

Production
Labor
Finances
Military aviation
Airlines
Personal flying
Exports, Lend-lease
Surplus Disposal
Service facilities
Training
Accidents
Aviation and other means of transportation
Research and development
Public opinion on aviation
Foreign aviation

In order to get a real idea of what it might mean to have the facts and figures provided in this handbook on hand at all times, on your office desk or bookshelf—in your home library—see and test it yourself for ten days' time.

Simply mail this coupon

McGRAW-HILL ON-APPROVAL COUPON

McGraw-Hill Book Co., 330 W. 42 St., N. Y. C. 18

Send me Aircraft Industries Assoc., AVIATION FACTS AND FIGURES, 1945 for 10 days' examination on approval. In 10 days I will send $2.50 plus few cents postage, or return book postpaid. (Postage paid on cash orders.)

Name .....
Address .....
City and State .....
Company .....
Position ..... AV 1-46

In Canada: mail to Embassy Book Company, 12 Richmond St. E., Toronto 1

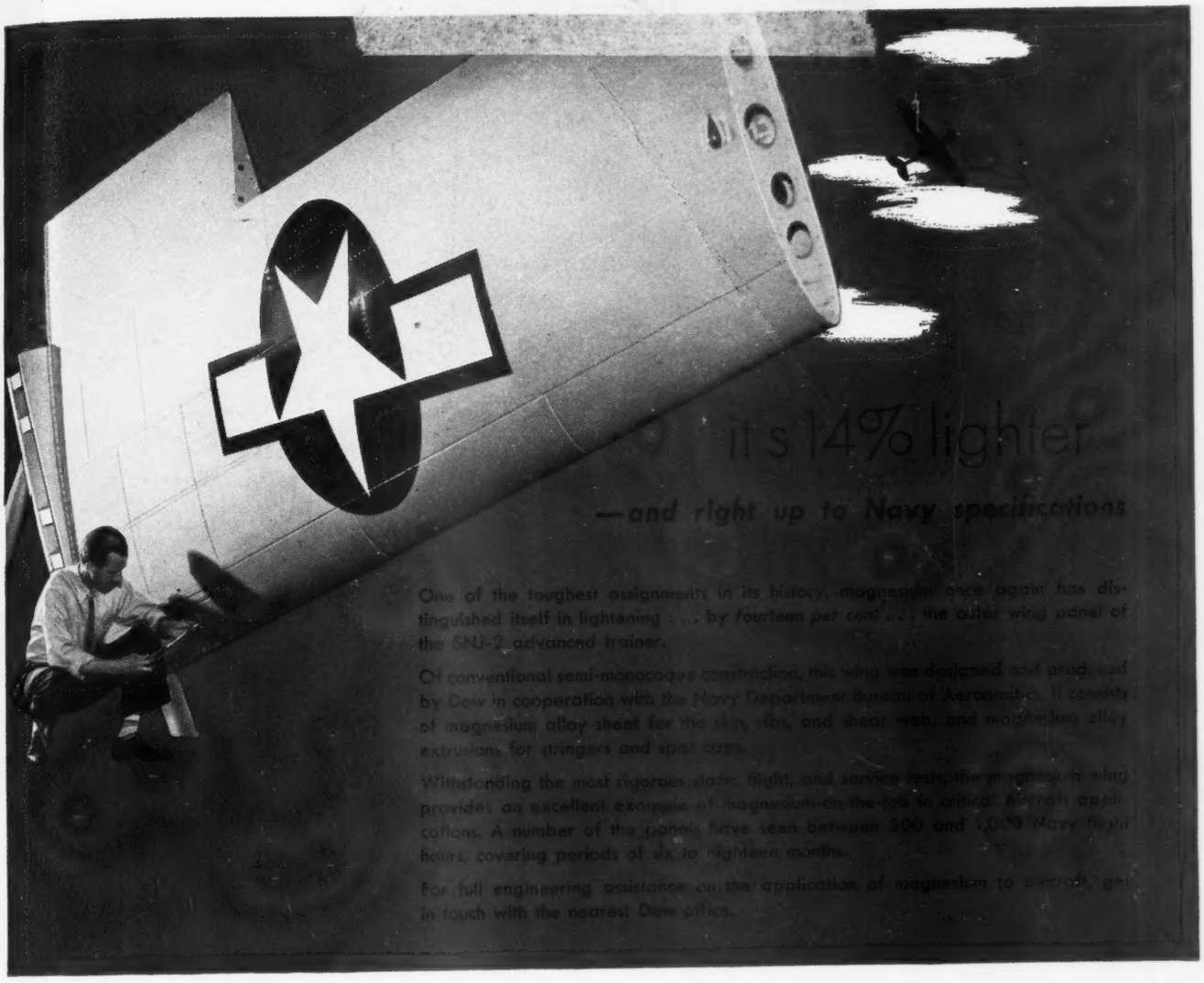
CP Universal Automatic Tappers

THE instant automatic control of CP Universal Automatic Tappers offers many advantages in production tapping and retapping. Tap breakage in blind, shallow holes or obstructions is minimized through the adjustable clutch, which slips at a predetermined overload. Reversing mechanism is also automatic — and speedy. Slight pressure affords right hand rotation, while backing tool away from work instantly reverses the rotation. Capacities range from 3/16″ to 3/8″ in steel and 3/8″ to 1/2″ in aluminum. Write for full data.

★★★★★★★★★
PNEUMATIC TOOLS
ELECTRIC TOOLS
HYDRAULIC TOOLS
ROCK DRILLS

CHICAGO PNEUMATIC
TOOL COMPANY
General Offices: 8 East 44th Street, New York 17, N. Y.

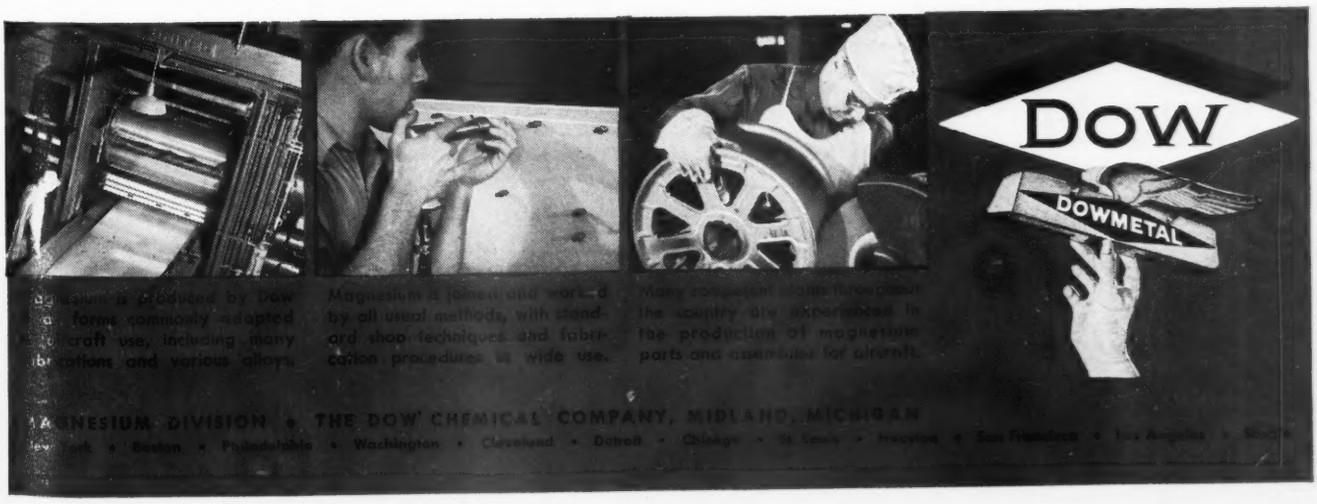
★★★★★★★★★
AIR COMPRESSORS
VACUUM PUMPS
DIESEL ENGINES
AVIATION ACCESSORIES


it's 14% lighter
—and right up to Navy specifications
One of the toughest assignments in its history, magnesium once again has distinguished itself in lightening . . . by fourteen per cent . . . the outer wing panel of the SNJ-2 advanced trainer.
Of conventional semi-monocoque construction, this wing was designed and produced by Dow in cooperation with the Navy Department Bureau of Aeronautics. It consists of magnesium alloy sheet for the skin, ribs, and shear web, and magnesium alloy extrusions for stringers and spar caps.
Withstanding the most rigorous static, flight, and service tests, the magnesium wing provides an excellent example of magnesium-on-the-job in critical aircraft applications. A number of the planes have seen between 500 and 1,000 Navy flight hours, covering periods of six to eighteen months.
For full engineering assistance on the application of magnesium to aircraft, get in touch with the nearest Dow office.

Ready . . . to make products move!

MAGNESIUM

LIGHTEST OF ALL STRUCTURAL METALS



Magnesium is produced by Dow in forms commonly adapted to aircraft use, including many fabrications and various alloys.

Magnesium is joined and worked by all usual methods, with standard shop techniques and fabrication procedures in wide use.

Many competent shops throughout the country are experienced in the production of magnesium parts and assemblies for aircraft.

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

STROMBERG

The Greatest Name in Aircraft Carburetion

Introduces

Injection Carburetion for the Light Plane Field!

In presenting this new P S Series Stromberg Carburetors, the advantages of Stromberg* Injection Carburetion, which equipped practically all military airplanes during the war, are made available for the first time to the private flyer and other users of light aircraft.

Non-icing characteristics; freedom from gravity effect in dives, climbs and banks, automatic compensation for temperature and altitude effect; predictable fuel consumption—all are safety and performance factors as important to light aircraft as they were on military airplanes—and all these advantages are incorporated in the new light plane Stromberg Injection Carburetors.

Available in various sizes for engines of 50 to 500 horsepower, this new Series of Injection Type Carburetors has been exhaustively tested in actual flight on small planes under severe atmospheric conditions and in the laboratory with the latest scientific testing equipment.

Measured by exacting standards of design, workmanship and performance, this new P S Series of Injection Carburetors are the most advanced product of STROMBERG—the Greatest Name in Aircraft Carburetion. For complete information write to:

Bendix

PRODUCTS DIVISION

Bendix Aviation Corporation, South Bend 20, Ind.

Bendix AVIATION CORPORATION

*REG. U. S. PAT. OFF.

RUARY 1946
OLLAR PER COPY

AVIATION

America's First Aeronautical Magazine

ESTABLISHED 1916

SALEM AIR STATION
U. S. COAST GUARD
FEB 16 1946
RECEIVED

13th Annual Directory Issue

ring our personal show in print, nting engineer-drawings and s of 42 new can types — plus on transports, ers, fighters, and d missiles — plus TION'S complete ication tables, in-g American and n turbojets — plus howplace of Ac-ies & Field Units. a greatly ex-ed Sketchbook of n Detail in color.

★

ECIAL REFERENCE FEATURES

al and financial anal-the industry's record ed with forecasts for re, and special reports VIATION'S foreign cor-lents.

★

DIO-CONTROLLED LS SPEED RESEARCH

ut gives det s of new method wh foretells nance — a does it reat savin in time ney.

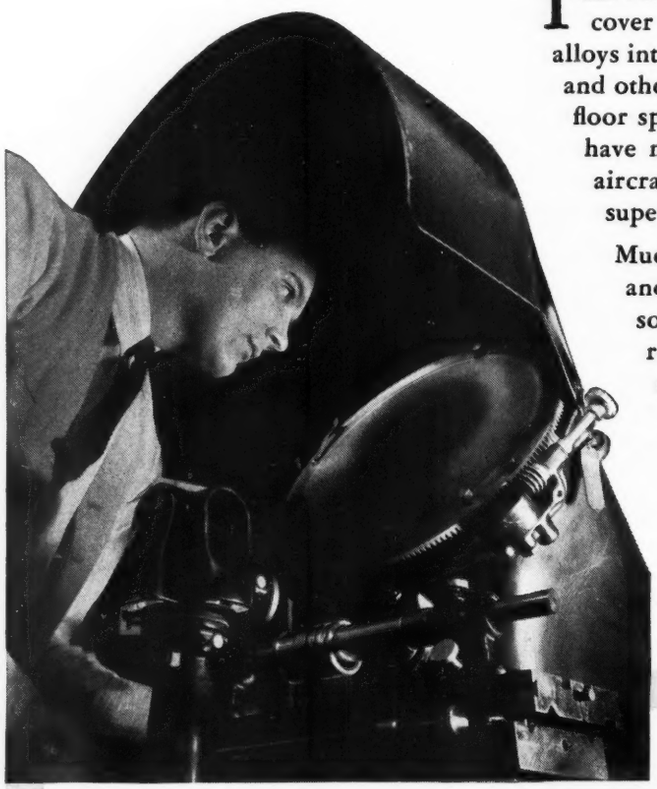
McGRAW-HILL
SHING COMPANY, INC.

CROP DUSTING—
just one of *many* uses

Controlled spraying and crop dusting for large or small areas is a "natural" for the versatile Sikorsky helicopters. These peacetime models will make available for industrial use the priceless experience gained during thousands of flight hours accumulated by Sikorsky helicopters in wartime service.

SIKORSKY AIRCRAFT
BRIDGEPORT, CONNECTICUT
ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

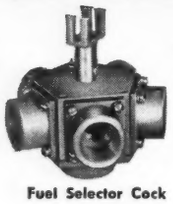
PRECISION .... Aircraft, Automotive and Industrial Parts



THE MANUFACTURING FACILITIES of Thompson Products cover every operation that's required to convert fine steels and alloys into precision parts and accessories for automotive, aircraft and other uses. Our company has plants in six cities with a total floor space of 2,600,000 square feet. Since 1901 our engineers have made many important contributions to automotive and aircraft progress—particularly in the development of parts with superior resistance to heat, corrosion, wear and tensile strains.

Much of our output goes into new cars, trucks, buses, tractors, and Diesel and plane engines as original equipment. Thompson engine and chassis parts are distributed for automotive replacement use through 3,500 wholesale jobbing concerns in the U. S. and Canada, and representatives in 98 foreign countries. Other typical products of our company are forged drill-shaft tips for the mining and construction industries, and railroad tie plate clamps.

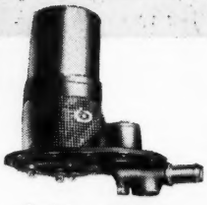
We invite inquiries from any concern that would like to know more about us as a possible source for hardened and ground precision products.



Fuel Selector Cock

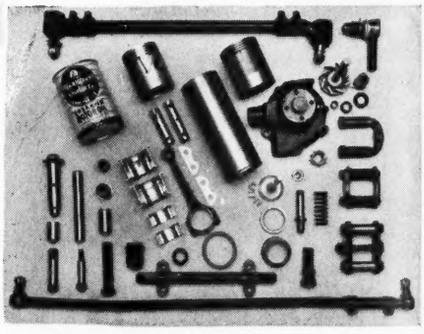
Sodium-Cooled Valves

Self-Adjusting Valve Tappet

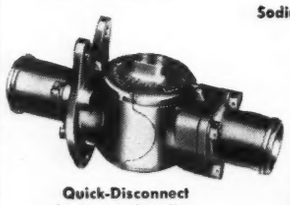


Fuel Booster Pump

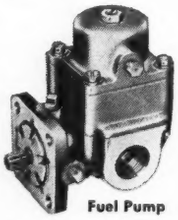
DRYdraulic Shock Absorber



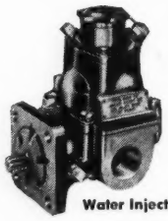
Hardened and ground precision parts for automotive and aircraft



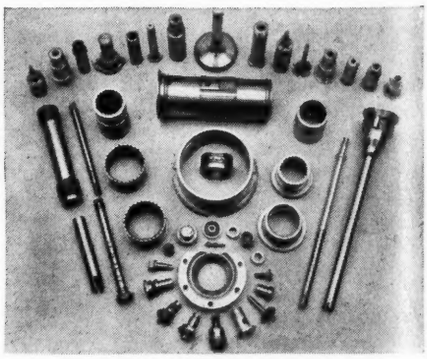
Quick-Disconnect Hydraulic Coupling



Fuel Pump



Water Injector



Turbo Super-charger

Oil Foam Breaker

Jet Engine Nozzle Diaphragm

Jet Engine Turbine Wheel

The Thompson Trophy, awarded at the National Air Races to foster higher air speeds, combined with practical maneuverability and safety.

Thompson Products

CLEVELAND · DETROIT · LOS ANGELES

During the war we produced over $425,000,000 worth of parts and accessories for Allied planes and mechanized equipment.